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PINK AND CHUM SALMON INVESTIGATIONS IN SOUTHEAST ALASKA, 1986-87

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March 1988

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Don W. Collinsworth
Commissioner

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ABSTRACT

Forecast data collection, preparation, and analysis continued to be the primary activity of the Pink and Chum Salmon Investigations Project during the period from July 6, 1986 through June 1987. The 1986 pink salmon (*Oncorhynchus gorbuscha)* return to Southeast Alaska totaled 62.6 million with a 45.7 million harvest and an escapement index of 17.0 million. In southern Southeast Alaska, which sustained the majority of the region's harvest (44.5 million), the total escapement index reached a new high of 14.0 million. In northern Southeast Alaska, the return was disappointing at 4.1 million, and the escapement index of 2.9 million was well below desired levels.

Early marine studies continued in Tenakee Inlet for the 11th consecutive year and in southern Southeast Alaska for the ninth year. In Tenakee Inlet the high correlation between survival (return per spawner) and fry lengths in May was statistically significant as it was from 1982 through 1985. In the southern Southeast Alaska studies outmigration timing appeared to be a better indication of survival, possibly because of the consistently richer marine environment. Studies of predation by coho smolts on pink and chum salmon fry were continued for the second year and indicate potentially significant predation particularly on years with poor overwinter survival and few numbers of fry in the early marine environment.

Key Words: Pink salmon, *Oncorhynchus gorbuscha*, Southeast Alaska, predation, early marine survival

INTRODUCTION

The Southeast Alaska pink salmon forecast research program was initiated in 1963. This report describes project activities during the period from July 1, 1986 through June 30, 1987.

The primary objective of the forecast research project is to develop techniques and background data to provide accurate annual preseason estimates of pink salmon returns to northern and southern Southeast Alaska. Annual pink salmon forecasts are of importance to the fishing industry, both fishermen and processors, for operational planning, and to fisheries managers for regulatory decision making.

Pink salmon returns to Southeast Alaska have been forecast with variable success since 1967. The forecast has been based on egg to fry survival of preemergent fry. In 1965 preemergent fry sampling was initiated on selected streams regionwide. In 1970, the program was expanded to include 12 new sample areas in seven new streams. In 1984, the entire southern area preemergent program was deleted as a result of budget reductions and in 1986, the entire northern area preemergent sampling program was deleted, also as a result of budget reductions.

Early marine survival studies of pink and chum salmon continued in 1986 for the 11th year in Tenakee Inlet, and the eighth year in the Ketchikan area. The primary purpose of these studies is to improve the reliability of the pink salmon adult return forecast.

One of the weaknesses of the current forecast method is that, because of lack of sufficient data, marine survival must be assumed to be constant. We know, however, that it is not constant and can vary greatly from year to year. The early marine fry survival studies are intended to help improve the forecasts by providing an index of how much and why early marine pink salmon fry survival varies from year to year.

This report describes the 1986 return and presents the 1987 pink salmon forecast. Specific project objectives include:

1. Continue developing techniques and a historical database to be used for developing techniques for accurate forecasts of the pink salmon returns to the benefit of the resource, fishermen, processors, and fisheries managers;

2. Determine optimum escapement levels for pink and chum salmon for each stream with documented escapements in Southeast Alaska;

3. To measure abundance, distribution, and growth of pink and chum salmon fry in marine nursery areas associated with the selected streams, and relate this to abundance and survival of returning adults;

4. To measure changes in selected environmental parameters and to determine if any relationship exists between these parameters and

pink and chum fry migration timing, abundance and size, and/or the subsequent abundance of returning adults.

PINK SALMON FORECASTS

Methods

Returns to the southern and northern areas of Southeast Alaska have been forecast separately because of differences in migration routes and run timing. While there are differences in the odd and even year returns we include all years in the regression analysis because we only have 21 years of fry information and breaking it in half would leave too little data for a meaningful analysis.

In 1986 we collected a number of separate data components for the forecast including preemergent fry density in 48 streams in the northern districts, monthly air temperatures and precipitation information at seven stations regionwide, spring estuarine conditions in Tenakee Inlet in northern Southeast Alaska and in four locations near Ketchikan, and district escapement levels regionwide. Detailed descriptions of the preemergent fry data collection methods used were described by Jones (1981).

The forecasts were developed using multiple linear regressions with the appropriate independent variables. In northern Southeast the forecast dependent variable was total return, and the independent variables were the preemergent fry index, average winter (November throught February) air temperatures and average air temperatures for April through June in northern Southeast Alaska. The southern Southeast forecast is the result of using 22 years of data to forecast survival (return per index spawner). Independent variables utilized in the regression analysis included: average minimum winter air temperatures in southern Southeast Alaska, the date of the coldest 15-day moving average winter temperature, and an estimate of escapement sex ratios.

Results

Pink salmon returns in 1986 exceeded expectations in the southern districts but were disappointing in most of the northern areas. The 1987 forecast indicates reduced returns as a result of severe over-winter conditions during November and December of the parent year (1985).

1986 Forecast Evaluation:

The 1986 pink salmon return was good in southern Southeast Alaska but returns were disappointing in the northern districts with an estimated total return to the region of 63.0 million (all harvest and escapements are preliminary data). Harvests in the region totaled 46.2 million (Figure 1).

In southern Southeast Alaska, the 1986 forecast of 37.9 million, was 7 million higher than any forecast since 1967. Preliminary data indicates that the return was 58.9 million, or 13.6 million above the upper end of

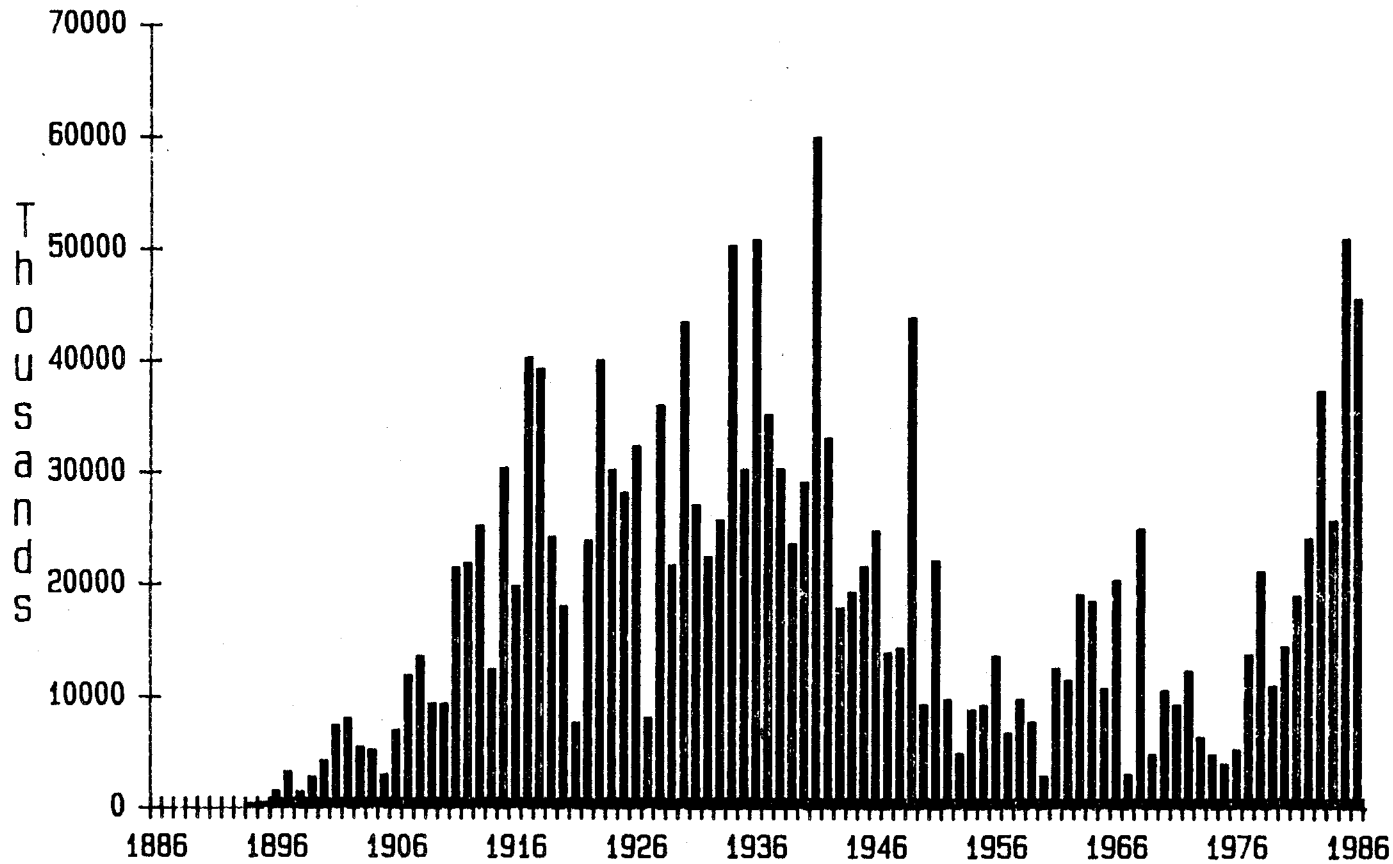


Figure 1. Southeast Alaska commercial pink salmon harvest, 1886 to present.

the forecast return range. The catch of 45.0 million was 5.7 million above the upper end of the forecasted catch range and 7.0 million above the previous all time record catch made in 1936.

The catch distribution of the 1986 return was very close to expectations. Preseason projections indicated that at least half of the southern Southeast Alaska catch would come from the West Coast of Prince of Wales Island in Districts 103 and 104 (Figure 2). Preliminary catch information indicates a catch from Districts 103 and 104 of 25.9 million or 58% of the total catch. The catch in District 101 was expected to be similar to that which occurred in 1985, but the acutal catch was 12.3 million or 34% above the 1985 catch. The District 102 catch was expected to be higher than it was in 1985; the actual catch of 5.3 million was over twice the 1985 catch. The 1.3 million harvest in Districts 105 through 108 was above expectations, however the escapement indices achieved in Districts 105 through 108 were somewhat disappointing in view of the record setting return.

While the 1986 forecast underestimated the actual southern Southeast return by 35%, it did contribute to an orderly fishery since it forewarned processors and management biologists to expect an exceptionally large return. The overall escapement index achieved in 1986 totaled 13.8 million. The District 101 through 103 total escapement index (Figure 3) reached 11.6 million for the first time since 1960. The escapement index achieved in Districts 105 through 108 (Figure 4) in 1986 was 2.2 million.

In northern Southeast Alaska, the total return in 1986 of 4.1 million was composed of 2.9 million total escapement and 1.2 million total harvest. This was a return per spawner of only 1.05 to 1. This was well below preseason estimates of 11.1 million and a return per spawner of 2.92 to 1.

The 1984/85 egg to fry survival in northern Southeast Alaska appeared to be above average based on the preemergent fry index so, most probably, high mortality occurred in the period of early marine residence. Indications from the program in Tenakee (covered later in this report) were that the 1985 early marine survival was one of the poorest since the early marine program was initiated in 1977.

Districts with the poorest escapements in 1986 were District 110, 111 and 114 which, when combined, realized an average of only 34.1% of the escapement goal. District 113 was also below goal levels with 46.1% of this goal. Districts 109 and 112 both reached their established escapement goal levels.

1987 Forecast:

The 1987 pink salmon return to southern Southeast Alaska is not expected to be as large as it has been in recent years. The 1987 prediction was made with the handicap of having the two most important variables (escapement and winter temperatures) outside of the range of anything experienced since statehood. In fact, there are several ways of comparing the winter conditions which indicate the winter of 1985-86 was the most severe winter since local record keeping was initiated in 1950. Figures 5 and 6 portray the relative severity of winter conditions from 1950 through 1986. The figure

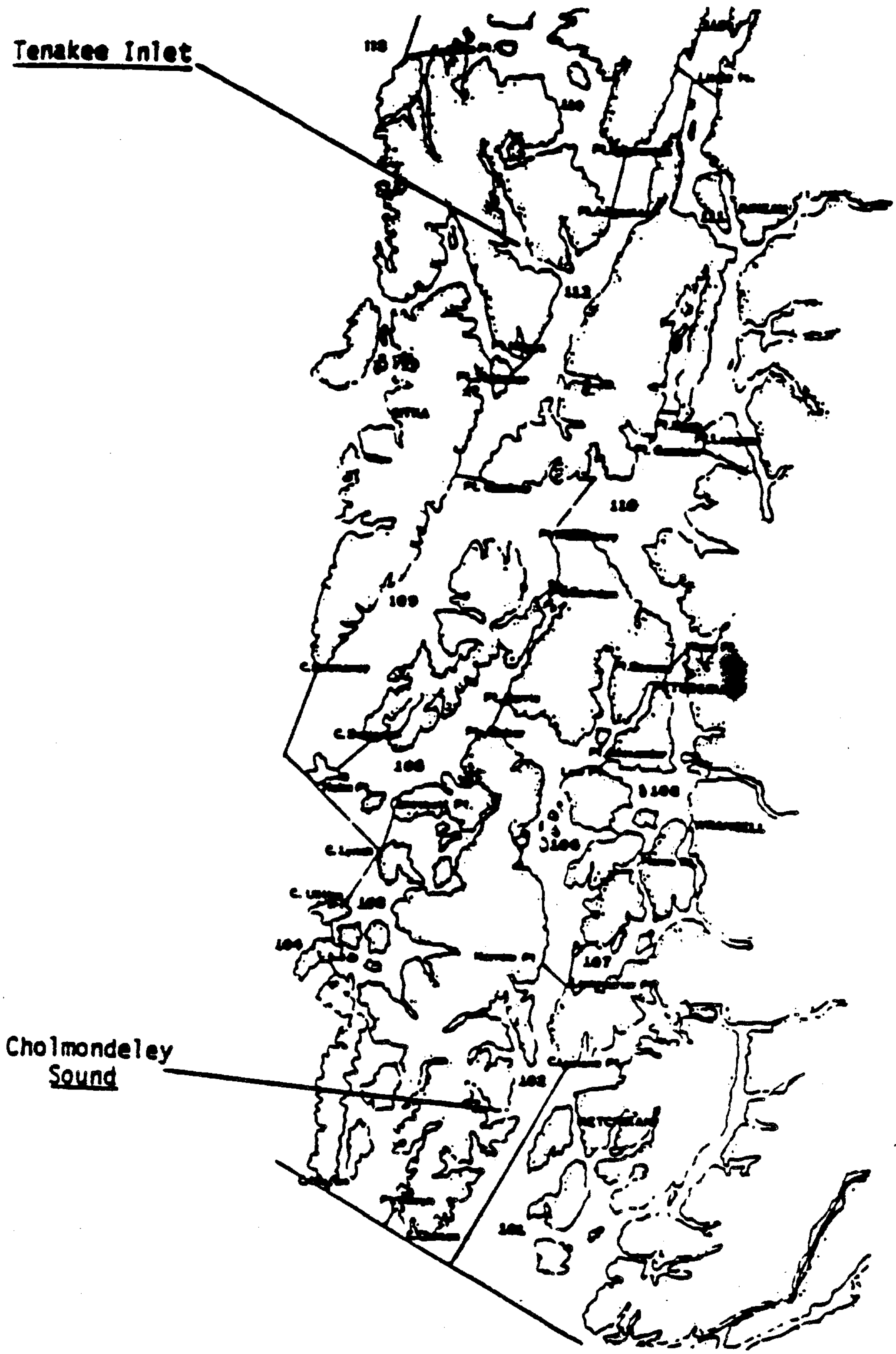


Figure 2. Southeastern Alaska regulatory districts and the location of Tenakee Inlet, Sitka Sound, and Cholmondeley Sound.

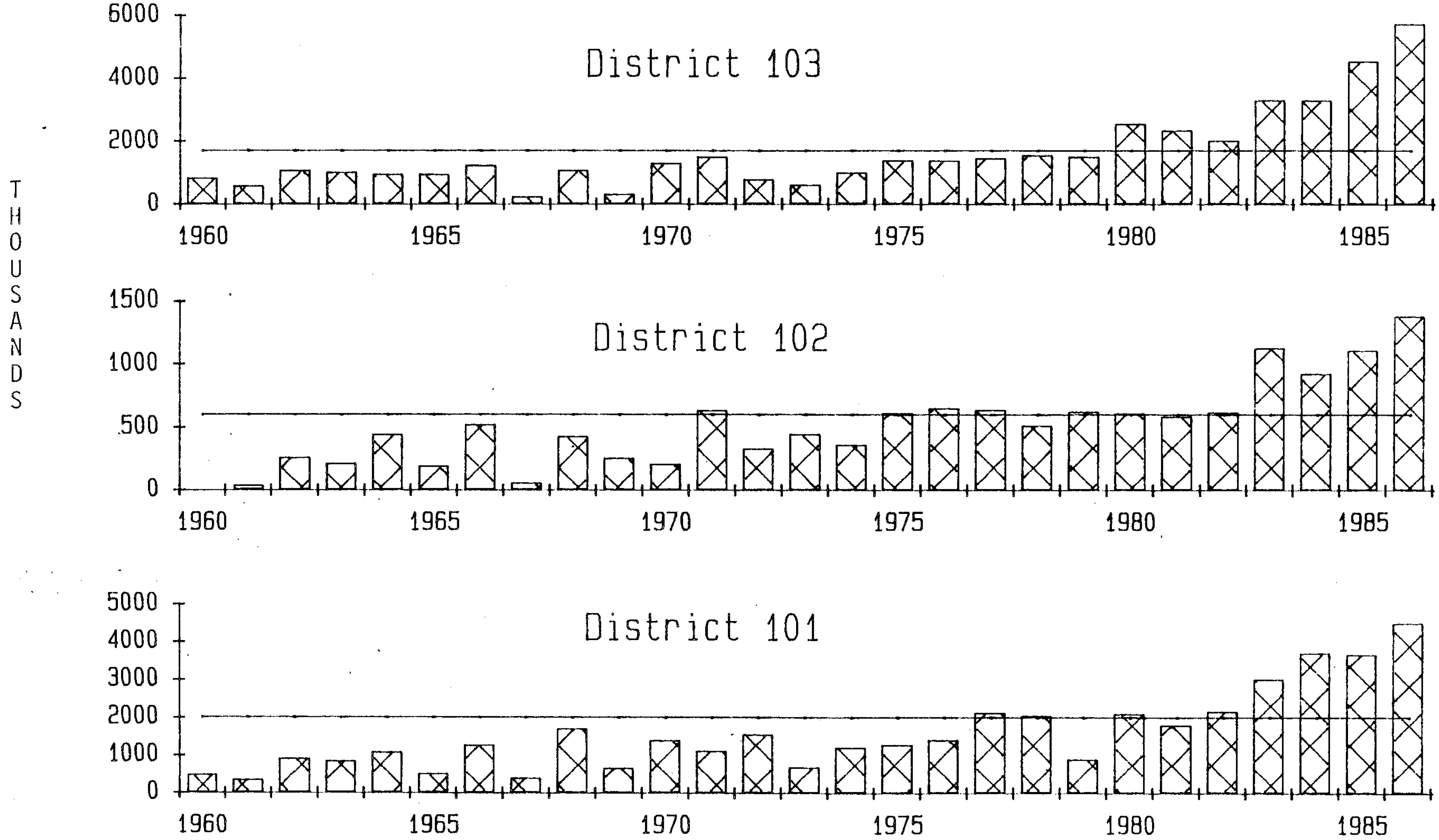


Figure 3. District escapement and escapement goals for Districts 101, 102, and 103.

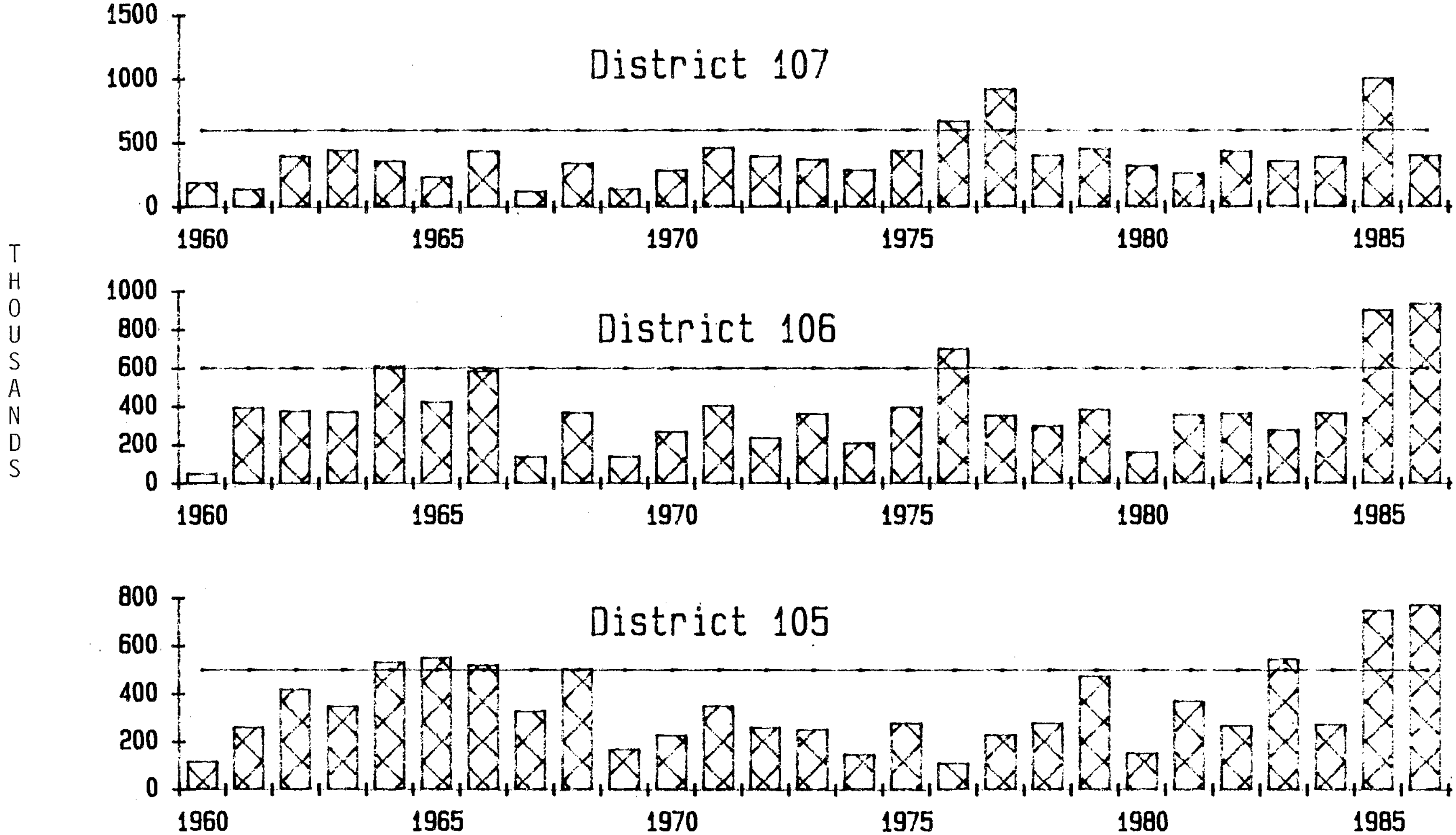


Figure 4. District escapement and escapement goals for Districts 105, 106, and 107.

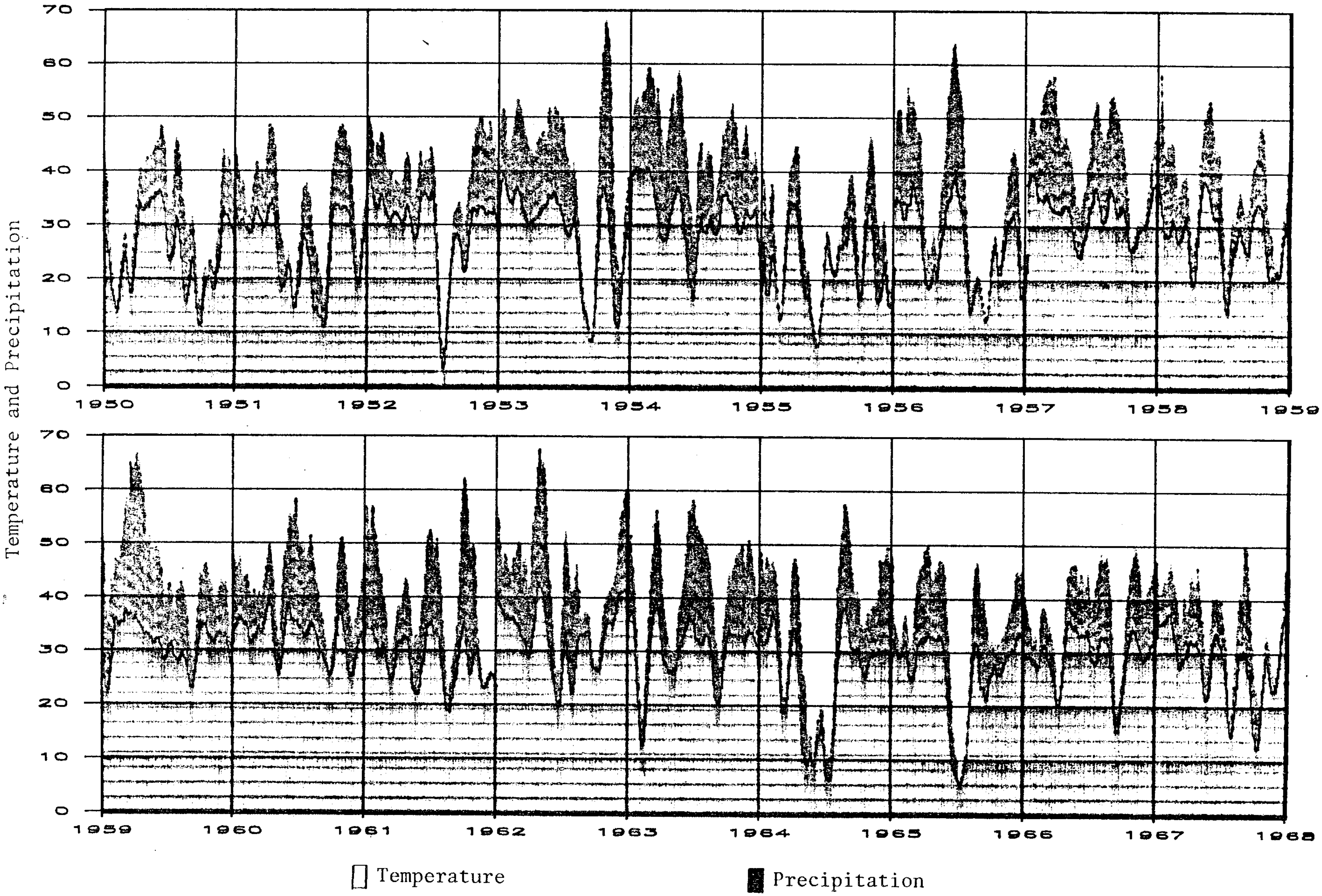


Figure 5. Daily temperature (7 day moving average) in degrees fahrenheit and precipitation (14 day moving average) in millimeters from Annette, Beaver Falls, Ketchikan, Petersburg, and Wrangell for 1 November through 28 February, 1950 through 1968.

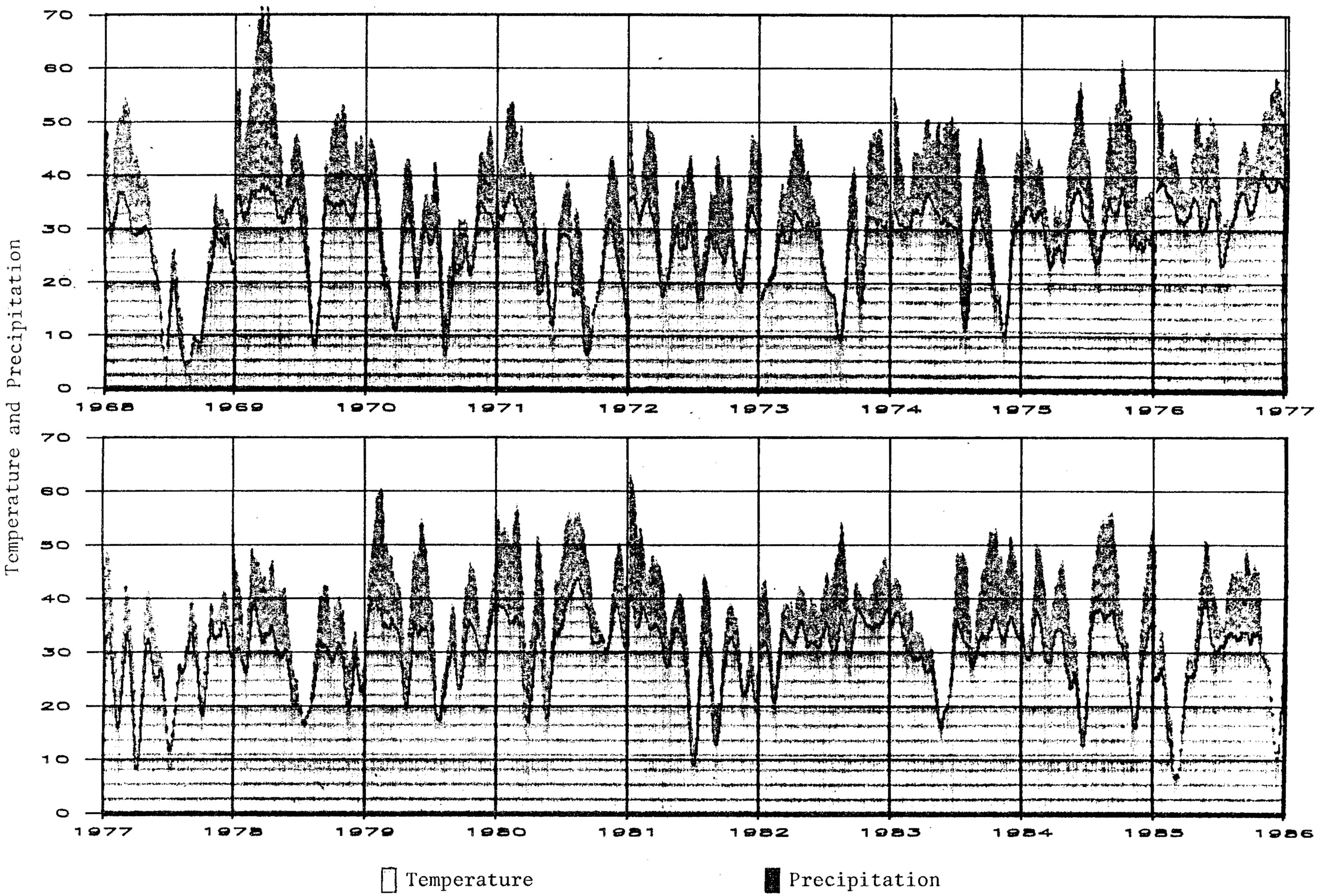


Figure 6. Daily temperature (7 day moving average) in degrees fahrenheit and precipitation (14 day moving average) in millimeters from Annette, Beaver Falls, Ketchikan, Petersburg, and Wrangell for 1 November through 28 February, 1968 through 1986.

is a stacked bar graph with 7-day moving average temperature in degrees Fahrenheit on the bottom and 14-day moving average precipitation in millimeters on the top; the annual time period is 1 November through the end of February. Each daily data point is an average of recordings from weather stations at Annette, Beaver Falls, Ketchikan, Petersburg, and Wrangell. The winter of 1985-1986 was one of only 6 winters since 1950 in which the total of temperature in degrees Fahrenheit and precipitation in millimeters fell below ten.

Regression analysis indicates that the date of the cold spell is also important with lower survival occurring in years when the cold spell hits earlier in the season. The cold spell in 1985-1986 was the earliest on record.

The exceptional escapement index obtained in 1985 of 12.3 million (3 million higher than anything achieved since statehood) is responsible for keeping the expected 1987 return above disaster levels. It is possible that the regression analysis utilized for the 1987 prediction over-estimated the influence of escapements and underestimated the influence of environmental conditions. Consequently, if there is an error in the 1987 prediction it is expected to be in the direction of overestimating the return.

The distribution of the 1987 return will be similar to that which occurred in 1979 with a very poor return to District 101 and the overall run looking extremely weak until well into the season. Early marine studies conducted in Behm Canal during the spring of 1986 documented very low pink salmon fry abundance. If the run materializes as expected, the fishing time allowable in District 104 will have to be restricted relative to recent years. This should result in greater than average numbers of fish available for harvest in Districts 102, 105, 106 and 107. The majority of the 1987 catch is expected to come from District 103.

In northern Southeast Alaska, the forecast point estimate of 9.7 million represents a return per spawner of 1.1 which is below average for the recent 19 years. A severe cold snap in late November and early December 1985 had a noticeable impact on overwinter survival. Not only were temperatures at record low levels for over three weeks, there was virtually no snow cover during the period to help insulate the streams and freezing probably penetrated deeper than it would have otherwise. Once the cold period ended, the temperatures rose rapidly, precipitation was very heavy, and the resulting scouring caused by large blocks of ice being swept out caused additional mortality. Preemergent fry values in March of 1986 were the lowest since 1981, reflecting the severity of the winter conditions.

Escapements in all districts were at, or near, the best levels since 1960 which should have helped to mitigate some of the effects of the extreme weather losses and because there will have been some additional production from areas that normally do not have any spawning.

District 109 had 1.3 million escapement (Figure 7) or 16% of the total for northern Southeast Alaska but the raw premergent fry index was just above average for the recent 20 year average. Red Bluff Bay had by far the best fry index in this district but it was well below the value for the past 2 years. Some levels of harvest are expected from this district.

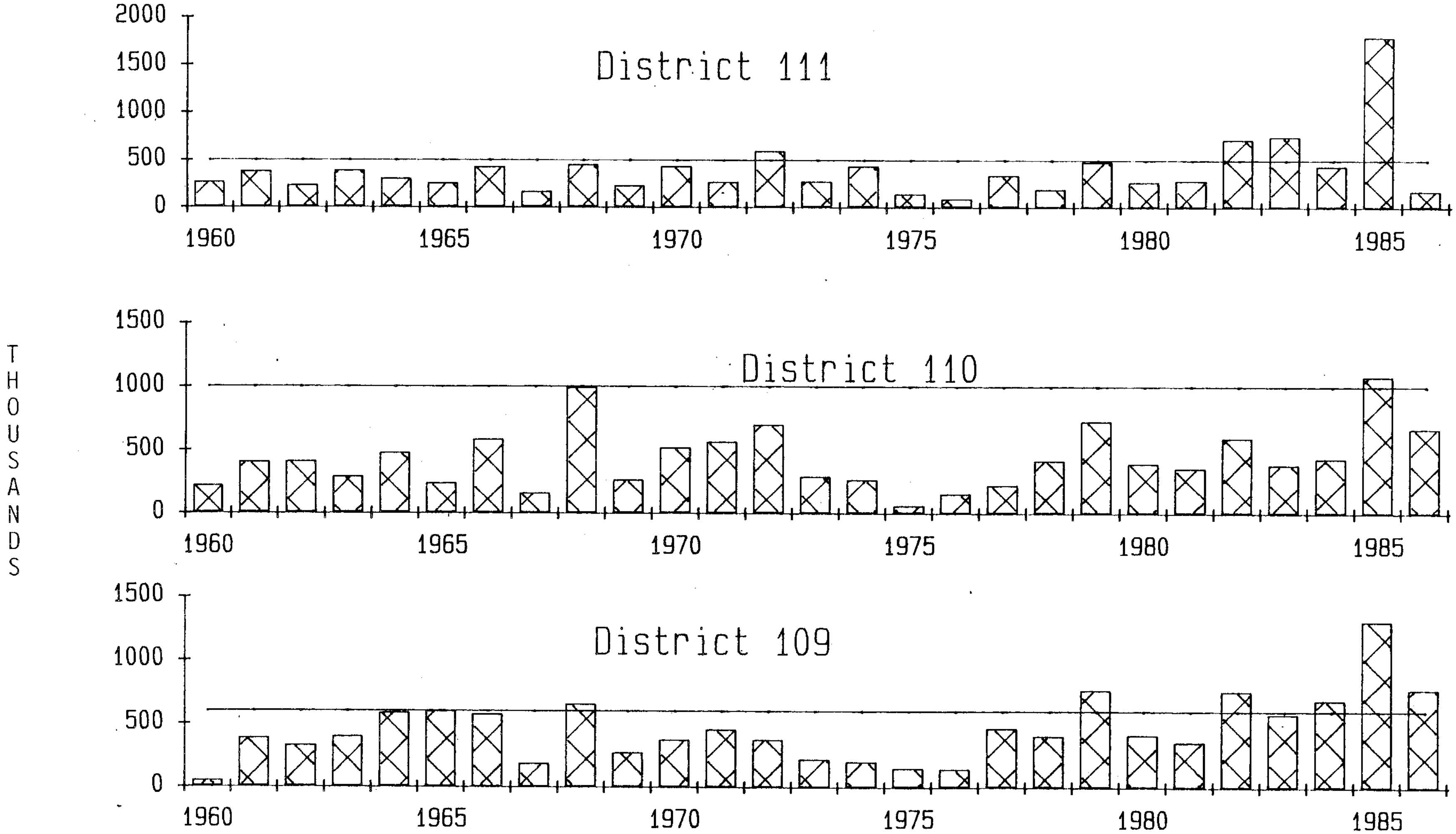


Figure 7. District escapement and escapement goals for Districts 109, 110, and 111.

District preemergent fry values for District 110 through 112 were all below the 1966 - 1986 average. In District 110 the stream with the best fry index was Glen Creek which had a fry index that just exceeded the recent 10 year average. In District 111 fry values were all well below those experienced in the recent three years. District 112 had strong fry indexes in only three of the 22 study areas, Lake Florence, Clear River in Kelp Bay and Seal Bay in Tenakee Inlet. Escapements were very strong in all three districts, however, and some harvest is also expected from these districts.

In District 113, escapements were strong (Figure 8) as in the other districts but fry values were generally well below those for the last two returns. Peril Straits had escapements that were over 200 thousand below goal levels and the fry index was the lowest since 1981 so little harvest is expected from these systems. The outer coast, however, had very strong escapements, totaling 2.3 million, or 28% of the total northern Southeast Alaska escapement. Fry values, while not exceptional, were not as bad as expected and harvestable surpluses are definitely expected from the outside coast.

District 114 had escapements in the parent-year of 581,000 but overwinter survival was poor, and the resulting raw fry index of 56.1 was the lowest since 1976. Little harvestable surplus is expected in this district.

EARLY MARINE SURVIVAL STUDIES

Tenakee Inlet

In 1986 the early marine survival studies were continued in the Tenakee Inlet area but only during the month of May as funds and personnel were not available to operate the project during April.

Methods:

Tenakee Inlet monitoring of fry populations and monitoring physical parameters was conducted in 1986. As a result of personnel and funding reductions in 1985, pink and chum salmon fry migrating from the Kadashan River, which drains into Tenakee Inlet (Figure 9), were not sampled in 1986. This was the second year in the 11-year study that we were not able to monitor outmigration timing in Kadashan River.

Fry abundance in Tenakee Inlet was monitored at least once each week by conducting visual surveys (Jones et al. 1982) along an index transect at Cannery Point (Figure 9). Other transects monitored on a regular but less frequent basis included Trap Bay, Corner Bay, and the Tenakee Boat Harbor. Fry were counted by one person wearing polarized sun glasses and standing in the bow of a 4 m skiff. The skiff was driven along the shoreline in water as shallow as possible, at speeds less than 6 knots, and numbers and locations of fry were recorded directly on maps at the time of observation. When the species composition of schools of fry could not be determined visually, or when fry samples were needed for growth determination, a dip net or beach seine was used to collect the fish for identification or

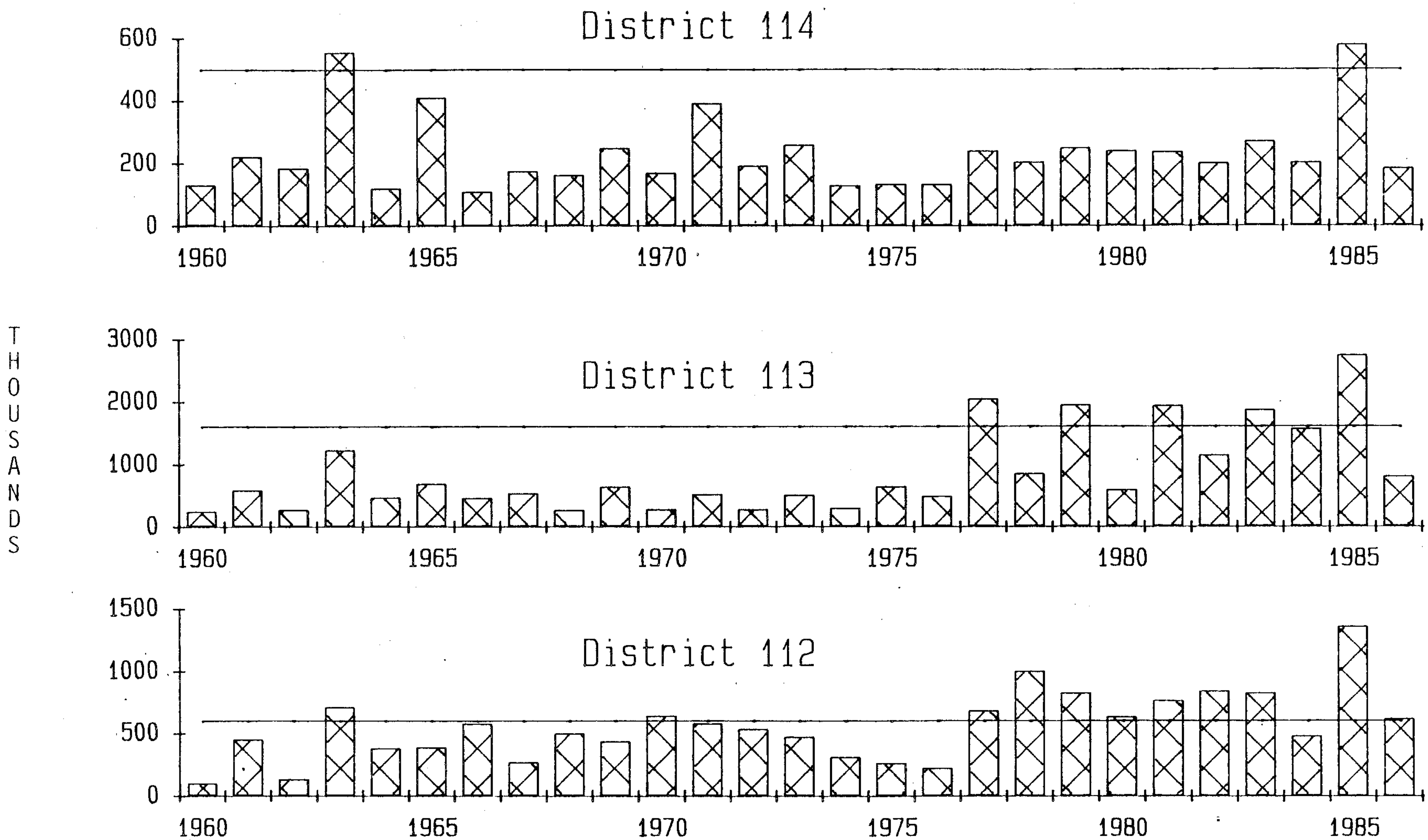


Figure 8. District escapement and escapement goals for Districts 112, 113, and 114.

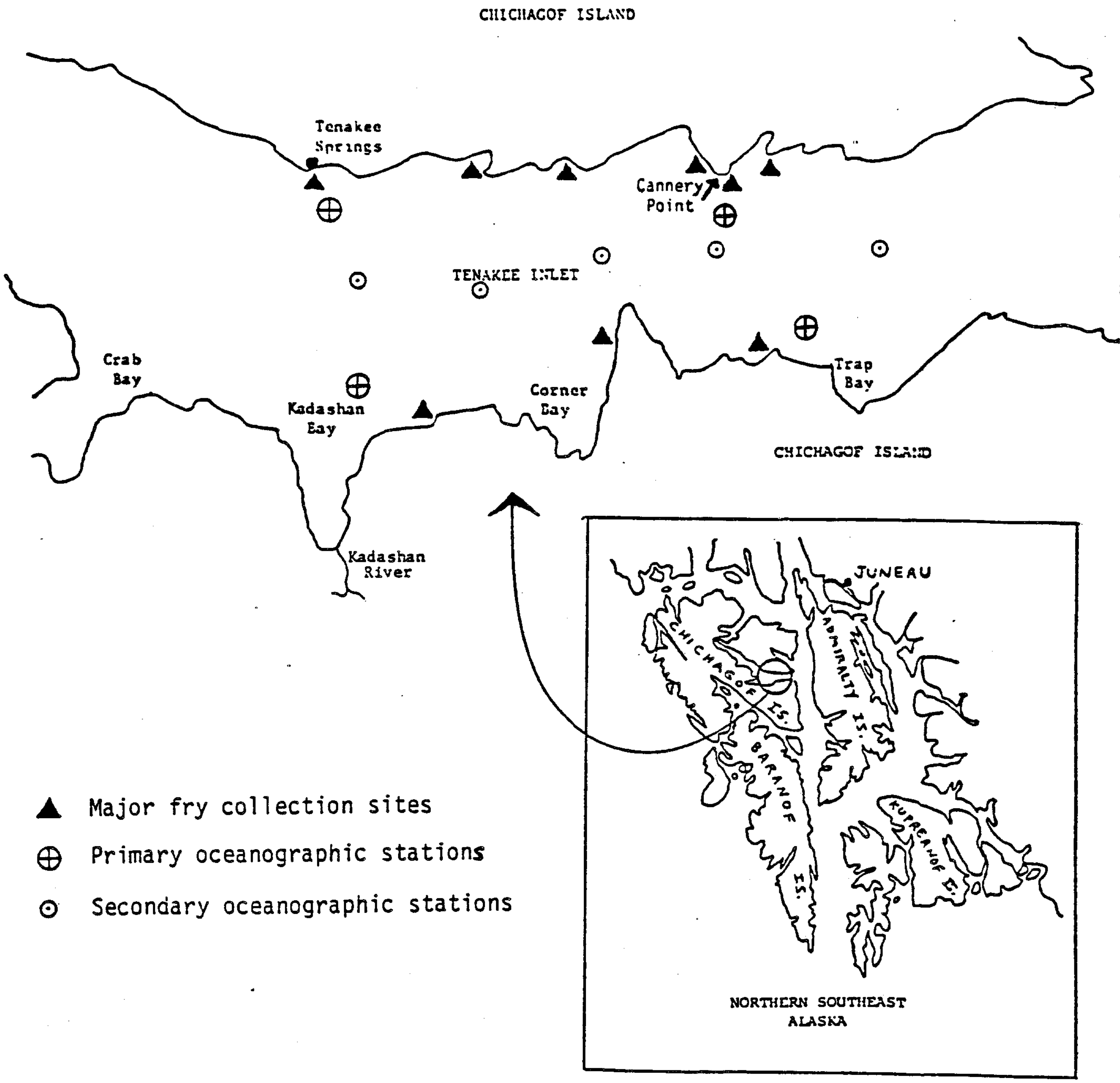


Figure 9. Major fry collection sites, primary and secondary oceanographic stations, and the location of Cannery Point, Tenakee Inlet, April-June 1986.

preservation. The beach seine measured 38.5 m long by 1.8 m deep, with a uniform rectangular mesh of 3.2 x 6.4 mm.

Fry were regularly collected during daylight hours from several locations in Tenakee Inlet, including Cannery Point. Based on the results of the 1984 gear and day-night sampling comparisons, it is felt that beach seine used during daylight hours provides the best cross section of the fry population present.

Tenakee Inlet water temperatures, salinities and clarity (secchi disc readings) were monitored at least once per week from May 1 through June 4 at the primary and secondary oceanographic stations shown in Figure 9. Temperatures and salinities were measured with a Beckman RS5-3 temperature/salinity/conductivity meter with a 15 m probe. Recordings were taken at 1-m intervals from the surface down to 10 meters. Water clarity was measured with a 20 cm diameter secchi disc.

Temperatures and salinities were taken at depth of 2 m. Readings at this depth are more stable than at shallower readings yet still well above the thermocline/halocline and, therefore, quite representative of waters inhabited by fry. Readings were taken from the surface to 10 m depth to insure that the thermocline/halocline was below 2 meters.

Results:

The peak number of pink salmon fry observed in Tenakee Inlet in 1986 was 1.5 million. No chum salmon fry were ever visually identified from the boat during the searches for schools to sample for lengths and weights. Nevertheless, chum fry were collected, mostly in beach seines, in association with pink salmon fry. This reinforces the previously documented unreliability of visual estimates for identifying chum fry in large schools of mixed species (Jones et al. 1982, Thomason and Jones 1985).

Pink salmon fry sampled in Tenakee Inlet increased from an average length and weight of 32.7 mm and 238.3 mg, respectively, on 1 May to 41.4 mm and 553.5 mg on 27 May for an average growth rate of 0.33 mm per day in length and 12.1 mg per day in weight. Chum salmon fry grew from an average length and weight of 38.6 mm and 453.1 mg, respectively, on May 1, to 50.7 mm and 736.5 mg on 27 May for an average growth rate of 0.47 mm per day in length and 10.9 gm in weight.

We computed the average pink fry fork length in May for 1977-1986 in Tenakee Inlet (Table 1) and compared it with the subsequent total adult pink salmon return per spawner ("return" is the escapement to all major spawning streams plus the commercial catch in Subdistrict 112-41 and 112-45 of Tenakee Inlet). We found a significant positive relationship between these parameters ($r = 0.667$, $P = 0.05$, $n = 9$). Thus, it appears that the average length of pink fry in Tenakee Inlet in May can continue to be used to estimate survival of the following year's return of adult pink salmon with a high degree of confidence (Jones et al. 1983, Thomason and Jones 1985).

We were concerned about not having a total harvest figure for the Tenakee Inlet stocks because some of the Tenakee Inlet bound pinks are intercepted

Table 1. Pink salmon return per spawner (R/S) and prior years fry fork length in May, Tenakee Inlet, for 1978-86 adult return years.

	Subdist 41-45 Harvest	Tenakee Inlet Escapement	Estimated 41-45 Return	Parent Year Escapement	Tenakee Rtn/Sp	NSE Rtn/Sp	May 1-20 Length
1978	480,121	522,208	1,002,329	130,623	7.67	4.15	43.7
1979	94,677	253,683	348,360	193,108	1.80	2.14	39.1
1980	98,397	263,897	362,294	522,208	0.69	1.28	37.4
1981	79,586	310,958	390,544	253,683	1.54	1.85	36.8
1982	551,465	364,540	916,005	263,897	3.47	5.90	38.7
1983	267,440	467,110	734,550	310,958	2.36	2.67	36.0
1984	139,561	179,411	318,972	364,540	0.87	2.04	38.9
1985	596,437	592,259	1,188,696	467,110	2.54	6.30	41.2
1986	99,792	507,582	607,374	179,411	3.39	1.05	36.4

in fisheries in upper Chatham and inner Icy Straits. We, therefore, tried using overall survival for northern Southeast Alaska as a potentially better indicator of overall brood year survival. The resulting correlation ($r = 0.852$, $p = 0.01$, $n = 9$) was exceptionally high. The high correlation may result in part from the strong correlation ($r = 0.579$, $p = 0.01$, $n = 21$) between average winter air temperatures and average spring sea surface temperatures. Median fry lengths in May, therefore, are probably a reflection of not only marine conditions but also of winter severity because spring marine temperatures are so highly correlated with over-winter temperatures.

We also plotted the annual peak counts of pink fry in Tenakee Inlet for 1977-85 against the resultant total adult returns to the Inlet for 1978-86 (catch from Subdistricts 42 and 45, plus escapements to all Inlet systems). We found a strong, positive relationship which strengthened our findings from previous years (Thomason and Jones 1985, Jones et al. 1983). The r-value of 0.78 is significant at the 95% confidence level (Sokal & Rohlf. 1969).

Sample sizes by week were checked to see if sample intensity was sufficient, and we found that after the middle of May the numbers need to be increased from 400 per week to a minimum of 500 per week to insure adequate numbers of fry in each length category.

During the shoreline transects in 1986 we saw more coho smolt than ever before. Several schools were observed that exceeded 150 smolt in areas of pink salmon fry concentrations apparently feeding on the pink fry. We were unable to capture any with the small seine we had available so no stomachs could be examined for content. In a typical year we saw very few schools of coho salmon and they seldom exceed 10-15 smolt. In 1986, large coho schools were observed on each of the four major transects.

While water temperature and level data from Kadashan River were collected too infrequently to be useful, weekly temperature and salinity observations were made in Tenakee Inlet. The average water temperature and salinity in Tenakee Inlet in May was 9.0^{o}C and 26.14 ppt, respectively (Appendix Table 5). Average surface temperature in the Inlet increased from 8.4^{o}C on 1 May to 10.9^{o}C on 4 June. The weekly trend was steadily rising temperatures with the exception of the third week of the study (May 20-21) in which the temperatures dropped significantly, probably in response to a series of storms passing through the area with associated high winds and rain.

Salinities also responded to the storms with no decrease in an otherwise steady trend of declining salinities. Normally, the halocline sets up as spring progresses and salinities drop as spring snow melt runoff dilutes the relatively stable water column. The wave action from periodic storms disturb the halocline and mix the stronger sub-surface water with the upper layers which temporarily increases salinities as seen during the week of May 21.

Conclusions and Recommendations:

The implications of our 1986 results and our recommendations for the early marine survival studies of pink and chum salmon in Tenakee Inlet are as follows:

1. The strong relationship between average pink salmon fry length in May and subsequent adult return per spawner in Tenakee Inlet, first noted for 1977-82 data (Thomason and Jones 1985), was further verified with the addition of 1985 fry/1986 adult return data. The positive relationship between pink fry survey counts and subsequent total adult returns was strengthened with the addition of 1986 data, narrowly missing significance at P = 0.05 for the 1978-86 adult return years. These relationships are being looked at closely in other pink fry rearing areas in Southeast Alaska with the hope that they can be incorporated into the pink salmon adult forecasting process.

2. It is felt that because of the high positive correlations between May fry lengths in Tenakee and the overall NSE brood years survival that additional areas should be sampled for fry size from late April through early June. The longer sample period will insure that adequate samples are taken through the critical period of early marine residence, and additional areas are needed to verify the relationship in general.

3. Tests on samples sizes from the 1986 data indicate that fry samples taken after mid-May need to be larger to insure adequate fry numbers in each length category.

4. The influence of freshwater stream runoff on temperature and salinity readings taken within 400 m of the mouth of a freshwater stream at mid to low tide emphasizes the necessity to keep the baseline temperature-salinity stations located at least 800 m offshore. It appears that, even in mid-inlet, some of the variation in temperature and salinity readings at the same station can be attributed solely to the influence of tidal flux. This means that a limited number of readings at the established stations probably have little, if any, meaning. The same stations need to be sampled at least once per day on a continuous basis for a period of several weeks in order to arrive at a meaningful average temperature and salinity.

5. Our findings that fry counts continue to vary less within days than between days lends further evidence to the validity of these counts as indices of fry abundance. The fact that somewhat higher fry counts are associated with higher tide levels needs to be incorporated as a standard survey requirement. The area between tide levels has less algae growth and, as a result, tends to be lighter in color which makes fry easier to see and count.

Ketchikan Area

Early marine survival studies in the Ketchikan area continued for the ninth year in 1986. Studies conducted from 1976 through 1978 were centered in

Cholmondeley Sound (Jones 1982). The program was reinitiated in 1981 with the study area expanded to include Moira Sound, Boca de Quadra, and Smeaton Bay. Since 1981, the emphasis of the study has been to obtain fry samples from marine nursery areas in the hope of finding a relationship between fry size or condition and early marine survival for use in improving forecasts. In addition, 1985 and 1986 studies included a cursory investigation on the impact of large scale releases of hatchery coho on the wild stock pink and chum salmon populations of the area. Budgetary constraints caused by including the coho study in the early marine program necessitated dropping Moria Sound from the early marine program in 1986.

Methods:

The timing and abundance of outmigrant fry from Sunny (102-40-87), Nigelius (101-45-94), and Spit (101-45-75) Creeks was monitored from 30 April through 10 June using a 0.45 m by 0.9 m fyke net placed to sample a column of water 0.45 m wide. Graphs of outmigrant timing and relative abundance were made by assuming an outmigration of zero on 3 March and 23 June. This was done in an attempt to standardize outmigrant magnitude since beginning and ending fyke netting periods often did not include the entire outmigration period. The index of relative abundance was obtained by calculating the area under the outmigration curve rather than summing the catches because the number of samples varied greatly between years.

The marine fry collection technique was changed in 1986 from night dippnetting to daylight beach seining. The change was made after comparison of fry collected by beach seine and dip net indicated that dip netting was a size selective capture technique when compared to beach seining (Jones 1986). The beach seine used in 1986 was 38 m long by 1.8 m deep, with a uniform mesh of 3.2 by 6.4 mm. No method was found to correct for the different collection techniques. Fry samples collected for length weight analysis from both fresh water and marine areas were preserved in a 10% buffered (sodium borate) formalin solution. The fry were measured and weighed approximately six months after collection.

Estimating fry abundance along premeasured transects was added to the study in 1986. Those areas which were known to be important nursery areas from past years observations were selected as transect locations (Figure 10). Fry numbers were estimated by a person wearing polarized sunglasses, standing in the bow of a 5.2 m skiff while it traveled at idle speed along the shoreline.

A coho predation study was conducted in 1985 and 1986 to estimate the impact of large numbers of hatchery fry on wild stock pink salmon populations in West Behm Canal. The study was centered in the Neets Bay area in 1985 (Figure 10). Rearing coho were captured with a 38 m by 1.8 m beach seine. In 1986 the study area was expanded to include Carroll Inlet and rearing king salmon were also sampled to determine the extent of their predation on pinks and chum. The beach seine used to capture the coho and king salmon in 1986 was 76 m by 1.8 m. In addition, a commercial seiner with an anchovy seine (100 fathoms by 10 fathoms) was utilized to collect coho and king salmon in 1986. Fry captured were preserved in 10% formalin solution, buffered to a pH of 7; formalin was also injected into the

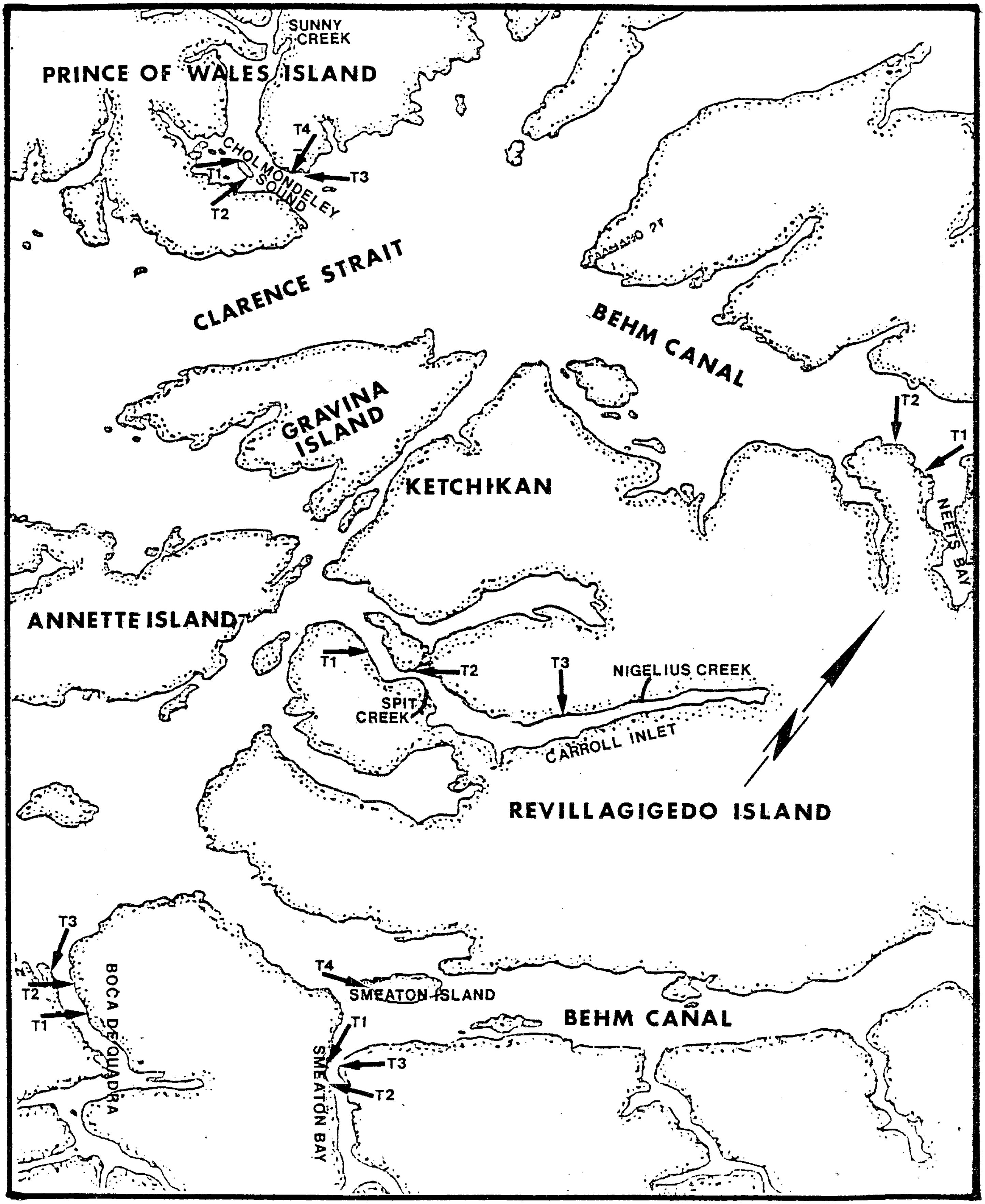


Figure 10. Map of early marine study areas and transect locations in southern Southeast Alaska.

stomach cavity to halt digestion. All length measurements were from tip of snout to fork of tail.

Results and Discussion:

The pink salmon outmigration from Sunny Creek in 1986 was already well underway at the time of the first fyke net set on 30 April. It peaked less than one week later on 7 May (Appendix Table 6). The date of peak outmigration and date of 50% outmigration was about average for the 1976 through 1986 time period (Figure 11). The index of relative abundance for chum salmon of 19,288 was the highest of the study period, while that for pinks of 94,275 was almost three times higher than the previous high of 32,557 in 1977. The data prior to 1985, however, can not be directly compared to 1985 and 1986 since a fish ladder was installed in 1984 which opened up additional spawning area.

Length frequency distributions of fry collected in the marine nursery areas during the early May (1 May through 14 May) and late May (15 May through 31 May) time periods are presented in Figures 12 & 13. It should be stressed that utilizing a beach seine in 1986 may have affected the length frequency distribution of fry relative to prior years because of the change in the collection technique (Jones 1986). It is interesting to note, however, that the frequency distribution of fry collected in early May 1986 is similar to those collected in 1982. The anomaly in 1982 was believed to be caused by the late outmigration in that year. If sampling had been conducted in 1986 prior to April 30, it is possible the outmigration curve would have more closely resembled that which occurred in 1977, 1982 and 1983 with very low outmigration magnitudes until a few days before the peak (Figure 11). It is believed the above may have occurred because of the similarity in length frequency distributions between 1982 and 1986 (Figure 12). Consequently, the 1986 pink salmon outmigration index may be exaggerated, and the date of 50% outmigration may have occurred later than indicated in Figure 11. The opposite extreme in outmigrant timing occurred in 1981 and that was also the year in which fry exhibited the greatest variation in length during early May.

The length frequency distribution and number of pinks consumed per coho in 1985 is presented in Figure 14. The Neets Bay Hatchery released 2.1 million coho on 1 June; consequently, the coho captured during the 22 May through 29 May time period were all wild stock coho. Those coho captured during the 3 June through 11 June period were both wild and hatchery, although from the length frequency distribution it would appear the vast majority were wild stock. Two possible explanations for the small number of hatchery coho in the catch are that the hatchery coho rapidly departed the area or that the net was size selective. Observations during the study suggested the net was an ineffective means of capturing coho as on numerous occasions water hauls (no coho captured) were made in areas where coho had been observed jumping immediately prior to the set.

The lower graph on Figure 14, portrays separate length frequency distributions for wild stock and hatchery coho captured with the beach seine. It includes only those coho captured after the hatchery release. The classification of hatchery verses wild is based on scale pattern analysis with wild stock defined as all two-check coho and one-check coho with 12 or fewer

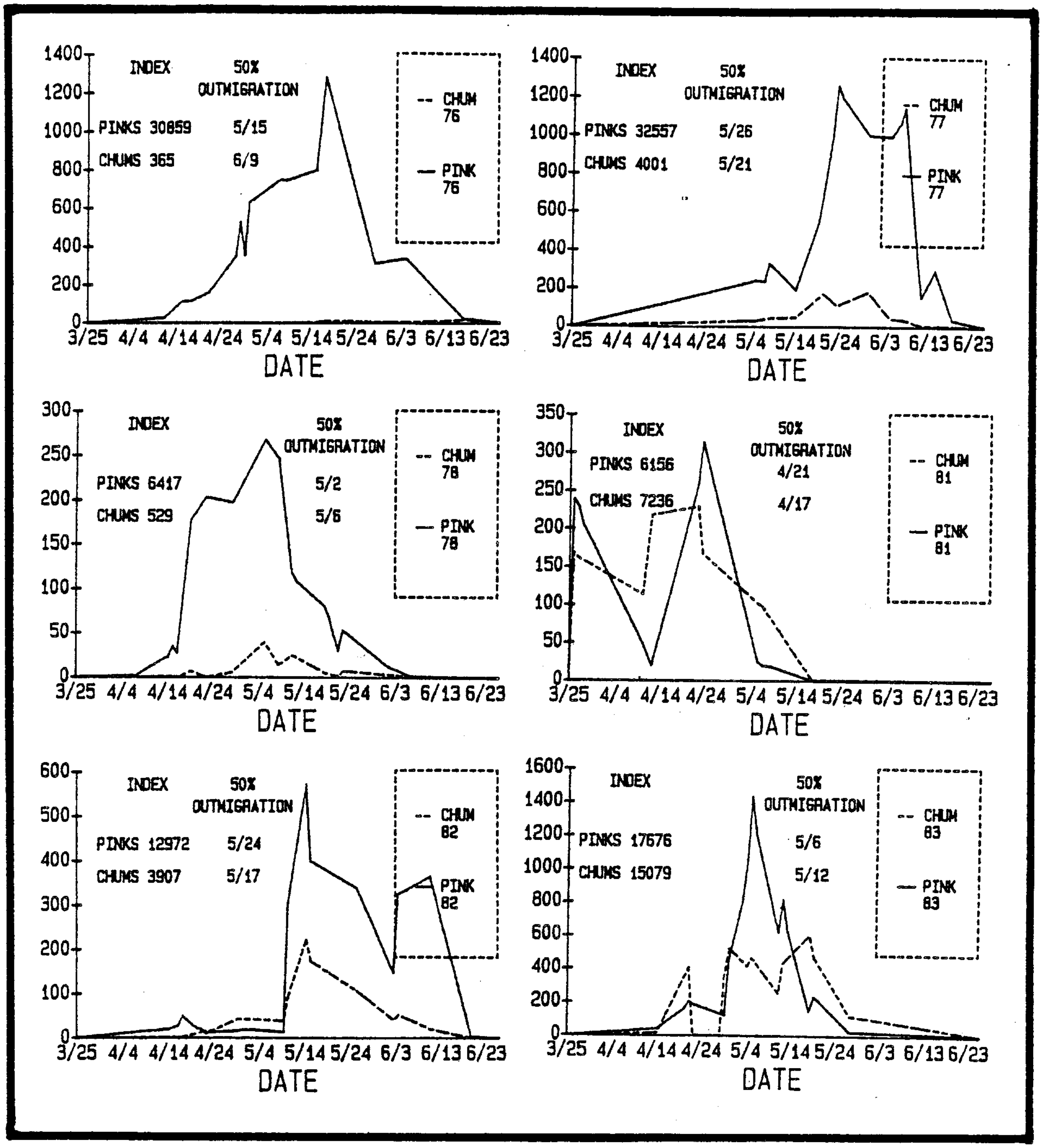


Figure 11. Pink and chum salmon outmigration from Sunny Creek 1976 through 1986.

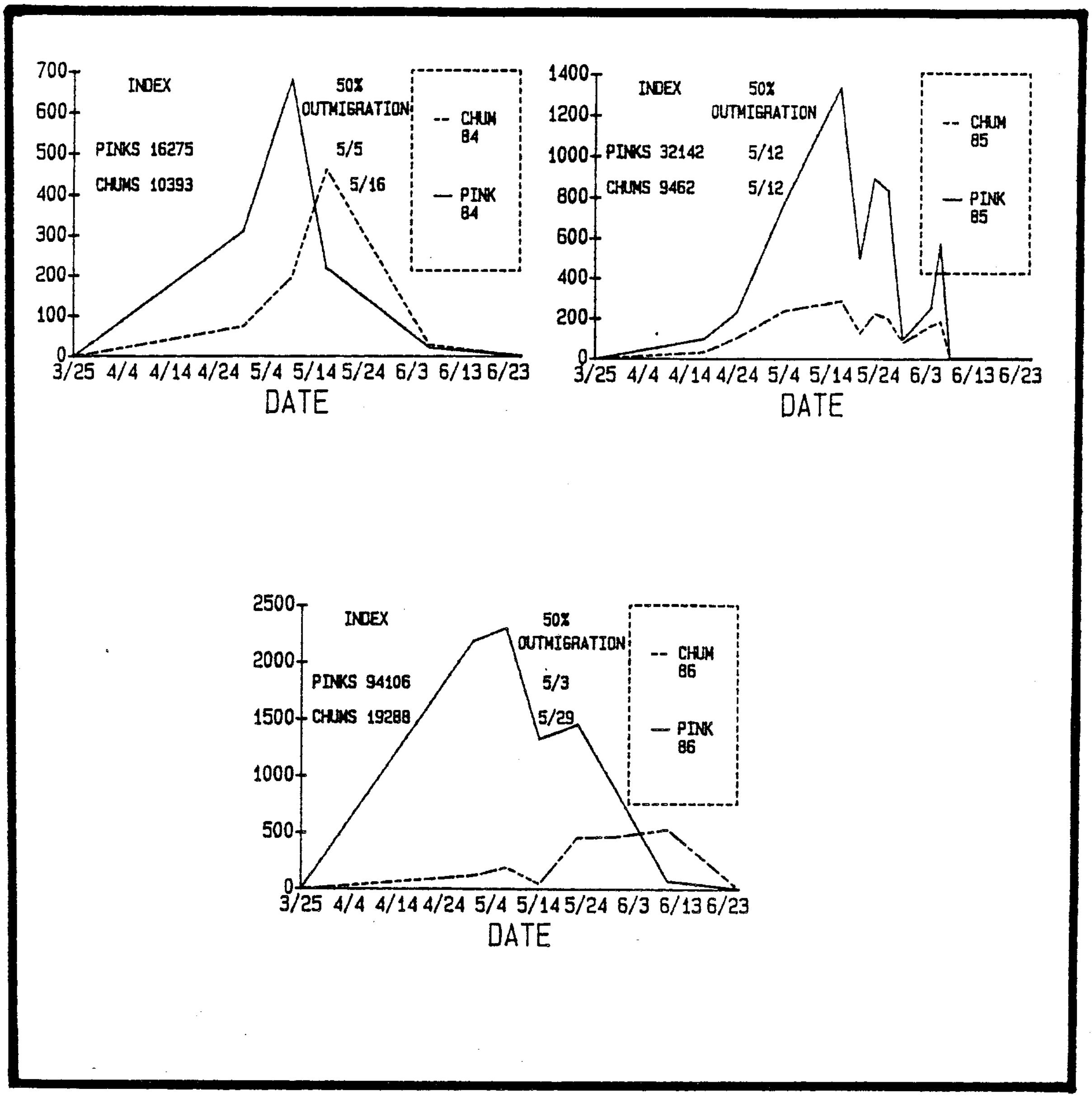


Figure 11. (Continued).

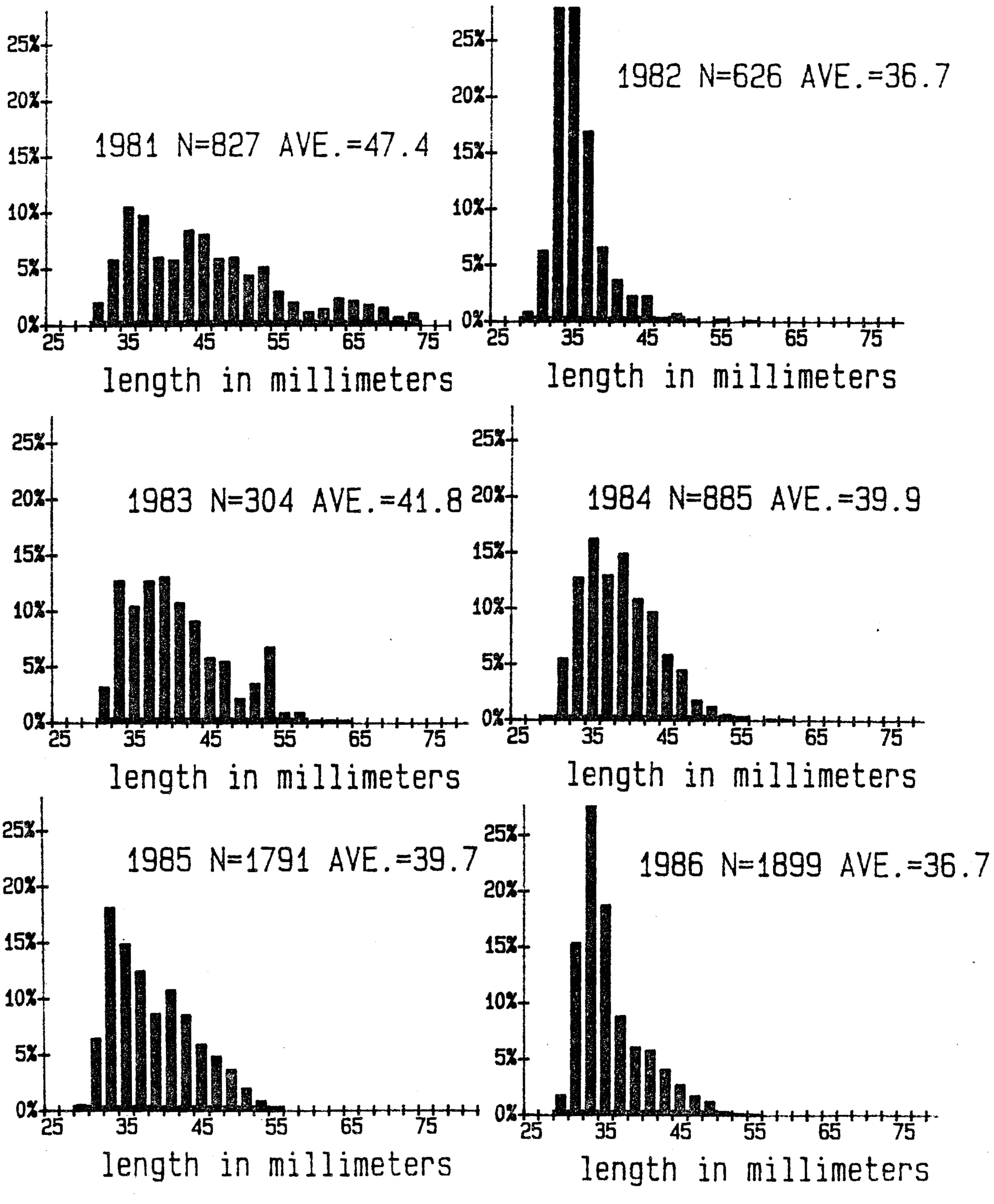


Figure 12. Length frequency distribution of pink salmon fry collected in early marine study areas of southern Southeast Alaska, May 1 to May 14.

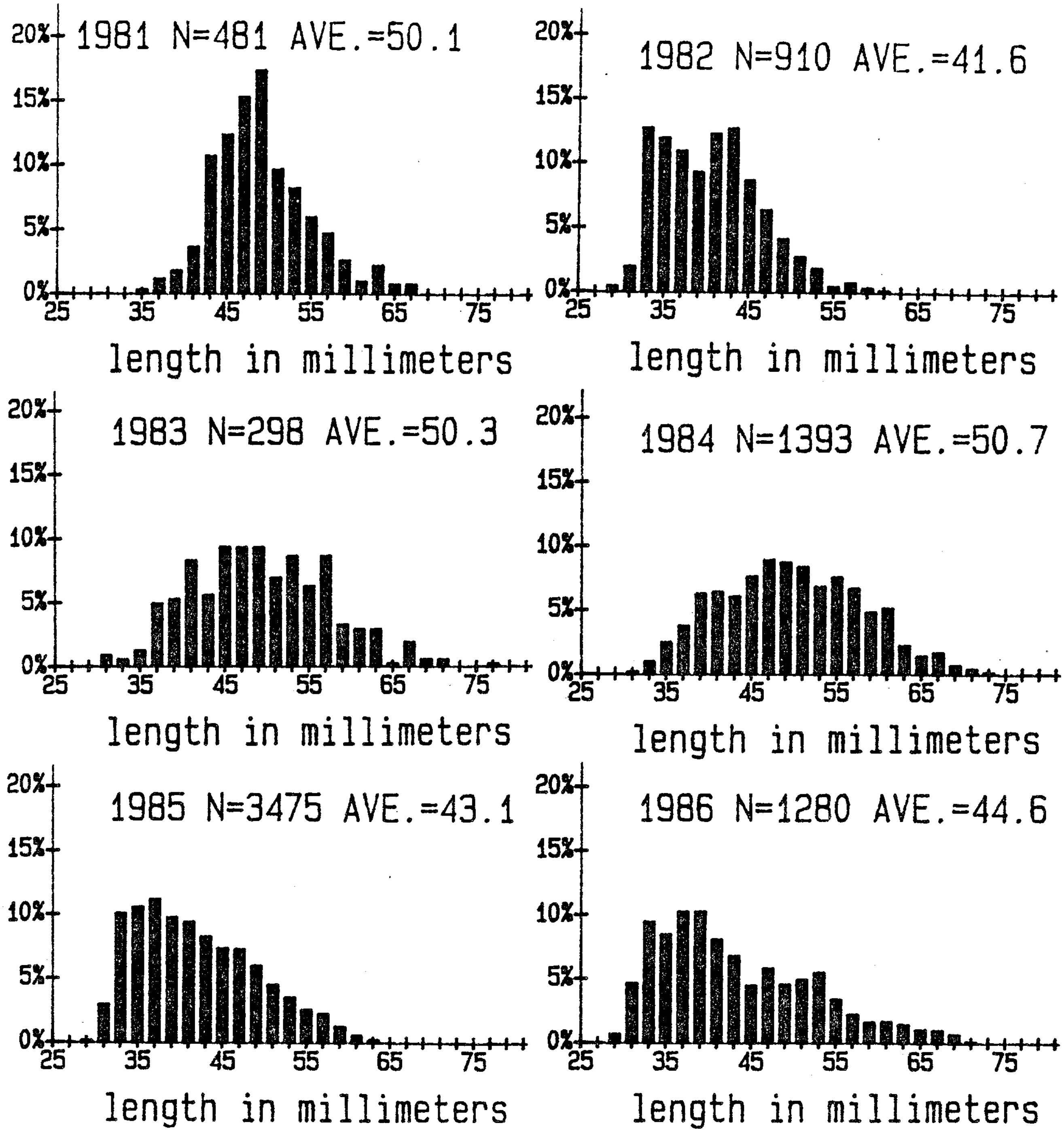
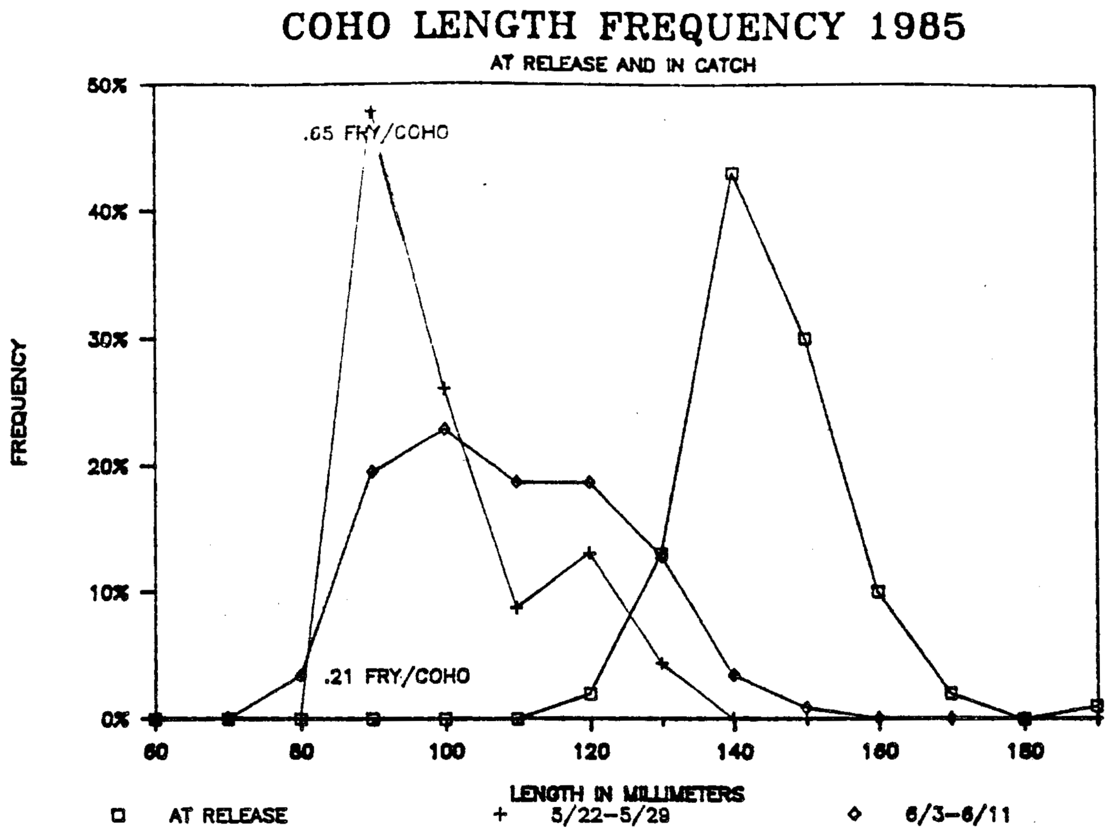


Figure 13. Length frequency distribution of pink salmon fry collected in early marine study areas of southern Southeast Alaska, May 15 to May 31.



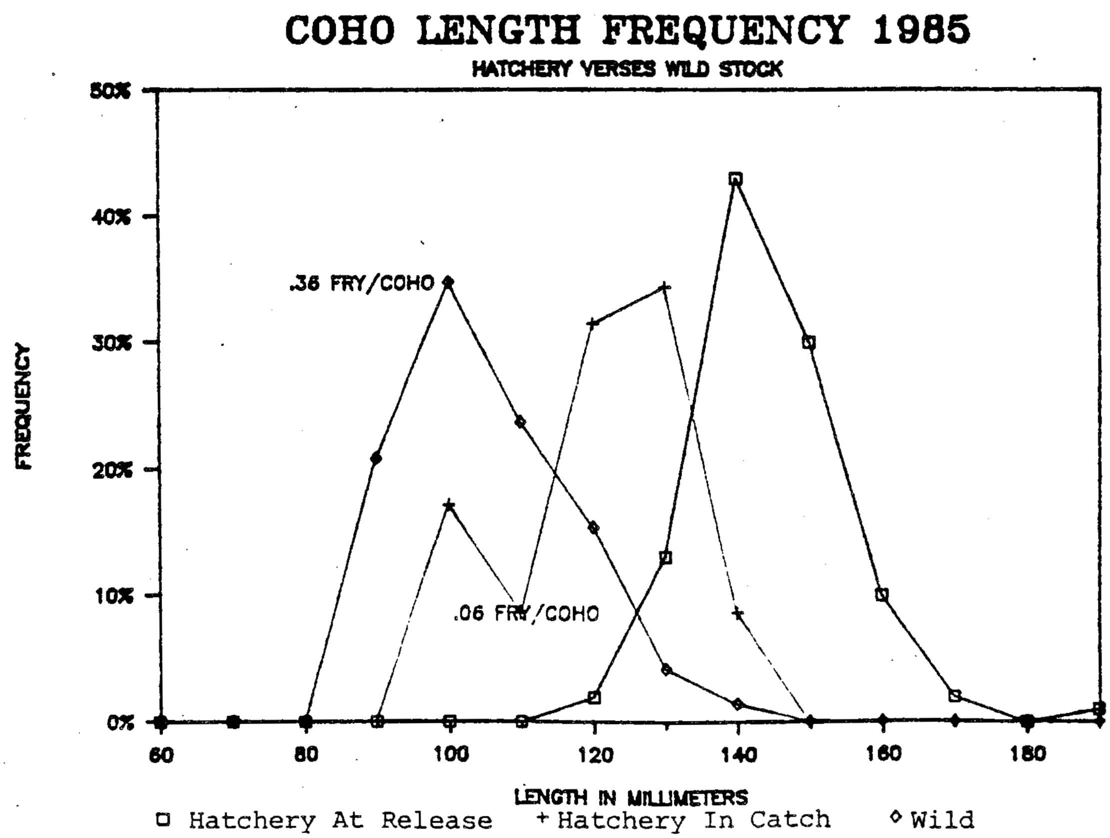


Figure 14. Coho length frequency and number of pinks consumed per coho captured during the 1985 study near Neets Bay.

circuli to the first check. A sample of wild stock coho from McDonald Lake was used as a known wild stock sample. Unfortunately, no known hatchery fry scales were available and consequently the accuracy of the method can not be evaluated. The figure suggests that the net was not effective for capturing larger coho (150 to 190 mm.). The average size of hatchery coho at release was 150 mm, consequently, the net was apparently selective against both hatchery and larger wild stock coho.

Figure 14 also suggests that hatchery coho utilize pink fry to a lesser degree than wild stock cohos; wild stock cohos had consumed 0.36 pinks per coho while hatchery coho had consumed 0.06 pinks per coho. Differences in the number of fry consumed per coho may have been a function of sample sizes more than any real difference in feeding behavior between hatchery and wild stock coho. The largest sample of the study period was on 3 June when 64 coho were captured; 29 were hatchery origin, 25 wild stock and 10 not classified do to lack of readable scales (Table 2). The number of fry consumed per coho during that sample day was the lowest of the study period for both hatchery (.03 fry per coho) and wild stock (.08 fry per coho). Sampling during the remainder of the study resulted in capturing an additional 46 coho's. Forty one were wild stock which had consumed .46 pinks per coho, only 5 hatchery coho were captured after 3 June 1 of which had consumed a pink. Consequently, a large part of the difference in fry consumption on Figure 14 is the result of having 85% of the total hatchery sample and only 38% of the wild stock sample come from a day and area when neither wild stock nor hatchery coho were relying heavily on pinks as a food source.

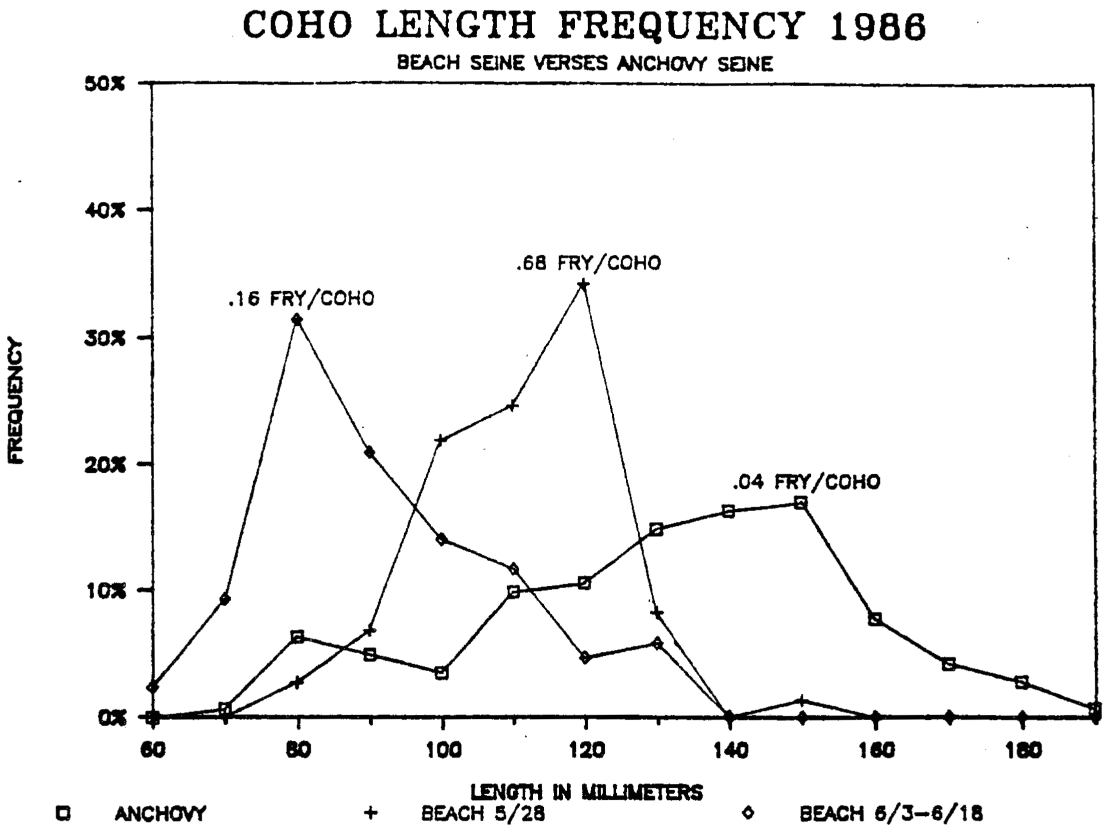
A study conducted by Bori Olla and reported on by John Omerongen (Omerogne 1987) suggests that no great differences in feeding behavior should be expected between hatchery and wild stock cohos. They reported that hatchery reared coho possessed an "easily awakened genetic predisposition to capturing live prey". Olla found that hatchery coho were as practiced as they were ever going to be at capturing live prey after only 2 h experience.

Sampling in 1986 verified that the net used in 1985 was selective for smaller sized smolt (Figure 15). In all cases the average size of salmon captured in the anchovy seine was significantly greater than the average size of salmon captured in the beach seine. The size selectivity of the beach seine in 1985 was probably even greater than 1986 since the length of the beach seine was doubled for the 1986 sampling.

The number of fry consumed per coho were very similar in the 1985 and 1986 beach seine samples. Prerelease (wild stock) coho captured by beach seine had consumed 0.65 and 0.68 fry per coho in 1985 and 1986 respectively. Post hatchery release (wild stock and hatchery) coho captured by beach seine had consumed 0.21 and 0.16 fry per coho in 1985 and 1986 respectively, but the number of pink salmon present in 1985 was many times greater than in 1986. Although the exact magnitude of the difference in fry densities is unknown, the return from 1985's outmigration was over 5 times greater than the return from 1986's outmigration. The number of coho released from Neets Bay in 1985 and 1986 was almost identical at 2.1 and 2.3 million, respectively. There is no reason to believe the population of wild stock coho was significantly different over the two years. No information is available to estimate the relative abundance of alternate

Table 2. Percent of Coho Consuming Fry by Area, Date, and Stock Origin

Date	Stock Origin or Location	Number of Coho	Number of Coho With at Least One Fry	Total Number of Fry Consumed	% of Coho With Fry	Fry Per Coho	Average for Time Period
5/22/85	Bushy Point	13	6	8	46	.62	
5/29/85	1 mile south						.65 fry/
	Bushy Point	10	7	7	70	.70	coho
6/3/85	Bushy Point	64	4	4	06	.06	
6/3/85	1 mile south						.06 fry/
	Bushy Point	5	0	0	0	0	coho
6/5/85	Bushy Point	4	2	2	50	.50	
6/5/85	1 mile south						
	Neets Bay	8	1	1	13	.13	
6/9/85	Bushy Point	20	10	12	50	.60	.43 fry/
6/9/85	1 mile south						coho
	Traitors	3	0	0	0	0	
6/11/85	1 mile north						
	Neets Bay	3	0	0	0	0	
6/11/85	Bushy Point	11	6	6	55	.55	
6/3/85	Hatchery	29	1	1	03	.03	.06 fry/
6/5-6/11	Hatchery	5	1	1	20	.20	coho
5/22-5/29	Wild	23	13	15	56	.65	
6/3/85	Wild	25	2	2	08	.08	.36 fry/
6/5-6/11	Wild	41	17	19	41	.46	coho



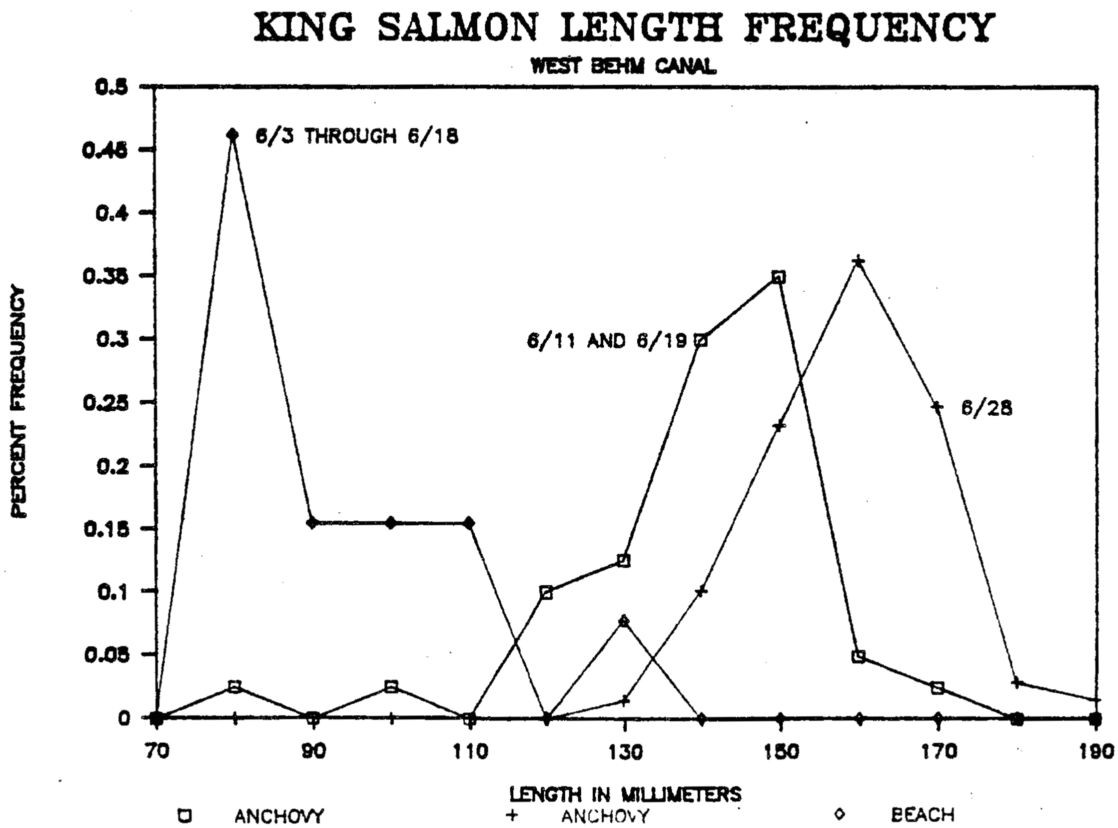


Figure 15. Coho and king salmon length frequency and number of pink salmon captured during the 1986 study near Neets Bay.

prey organisms in 1985 and 1986. Information on stomach fullness, however, suggests that the coho were less well fed in 1986 than 1985. Stomach fullness was estimated as percent full at the time of dissection. The results in 1985 showed an average fullness index of 0.65 while in 1986 the index was 0.42. These data suggest that the coho may be actively seeking out pinks rather than preying on them in a density dependent fashion.

Differences in the number of fry consumed per coho shown in Figure 15 could be the result of differences in date or area of capture. Two different habitat types were sampled. The beach seine was only effective sampling along shallow relatively gently sloping shorelines; while the achovy seine required steep almost vertically walled shorelines to insure the 10 fathom deep net did not tangle on the bottom. Unfortunately, very little overlap is present in the two sample techniques since a commercial seiner was not available until 11 June and beach seining became ineffective after mid-June.

Consequently, it is not possible to determine if area of capture had any affect on the pinks consumed per coho parameter. It does appear that the date of capture strongly influences the number of pinks consumed. In both 1985 and 1986, coho captured in beach seines were relying more heavily on pinks as a food source early in the sample period than they were late in the sample period. If the coho caught in 1986 by the anchovy seine are broken into time periods the results are: 11 June, 4 pinks were consumed by 42 coho; on 19 June, 1 pink was consumed by 87 coho; and on 28 June, no pinks were consumed by 12 coho.

The king to coho ratio present in the anchovy seine catch suggested that coho were departing the area before the kings. A total of 42 coho and 3 kings were captured during the first day of anchovy seine sampling on 11 June, for a ratio of 14 coho to each king. This was probably somewhat exaggerated since problems with the power skiff resulted in sets being made closer to shore than was the case in the last two sample days. The sample from 19 June, contained 87 coho and 37 kings for a ratio of 2.35 to 1; which was very close to the actual release ratio of 2.53 to 1. Sampling during the last day on 28 June resulted in a catch of 12 coho and 69 kings for a ratio of 0.17 cohos per king salmon.

The information collected in 1986 indicates that, at least in years of low pink salmon abundance, king salmon are not important predators on pinks. A total of 121 kings were collected and only 1 was found to contain a pink salmon. That king was a coded wire tagged (CWT) fish released from the Deer Mountain Hatchery in Ketchikan. Of the kings captured, 19 were tagged. Eight of the 19 were from the Deer Mountain Hatchery which released at tagging intensities of from 99% to just over 50% depending on the tag lots. Nine of the recoveries were from Whitman Lake facility (near Ketchikan) which released at tagging intensities similar to Deer Mountain. Two were from the Neets Bay facility in West Behm Canal which released at tagging intensities of approximately 25 to 1. Although the sample sizes are small, two things are apparent from the CWT data: (1) very few wild stock king salmon were captured, and (2) a significant number of George and Carroll Inlet hatchery king salmon moved into West Behm Canal to feed.

Distinguishing between pink and chum salmon after the fish has been in a coho stomach for several hours is impossible. In approximately 20% of the cases the salmon was recognizable to species, and in all of those cases the fish was identified as a pink salmon. Observations in the field also suggested that the coho were selecting for pink salmon. A beach seine set made in Boca de Quadra caught over 100 chum, 15 pink and 3 coho salmon. Two of the coho caught in that set had recently consumed pink salmon, no chum salmon had been consumed. Hargraves (1985) also found coho to be species selective favoring pinks over chum; although the coho in his study were utilizing chum salmon as food source to some extent.

Conclusions and Recommendations:

1. The information obtained to date on coho predation indicates that delaying releases of coho until early June greatly reduced the impact of hatchery coho on wild stock pink salmon fry. It also appeared that the impact of predation could be further reduced by delaying releases an additional two weeks.

2. The extent of increased coho mortality caused by delaying releases an additional 2 weeks while hatchery holding area water temperatures are approaching critical levels may make later releases economically unacceptable in most years. However, if coho predation on pink salmon is density independent as the data suggests, it would be economically and biologically necessary to delay coho releases in years of low pink salmon abundance.

3. Every effort should be made to increase the number of fyke net sample days early in the outmigration period so that the shape of the outmigration curve can be more closely defined.

LITERATURE CITED

Jones, J. D. and J. Dangel. 1981. Southeastern Alaska 1980 brood year pink (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) escapement surveys and pre-emergent fry program. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 66. Juneau.

Jones, J. D., G. Thomason, J. Dangel, and K. Hofmeister. 1982. Pink salmon stock predictions - S.E. Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Project No. AFC-59-3, Anadromous Fish Conservation Act, Technical Report for July 1, 1980 to June 30, 1981, Juneau.

Thomason, G. and J. D. Jones. In Press. Early marine survival studies of pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon in Southeastern Alaska, 1976-1982. Alaska Deptartment of Fish and Game, Commercial Fisheries Division, Informational Leaflet, Juneau.

Sokal, R. R. and F. J. Rohlf. 1969. Biometry. Freeman Company, San Francisco, California.

Omerogne, J. 1987. In salmon school the favorite subject was lunch. Alaska Fishermans Journal, February, 1987: 34 - 35.

APPENDICES

Appendix Table 1. Northern and southern Southeast Alaska harvest, escapement, return and return/spawner, 1960-86.

	Northern Southeastern				Southern Southeastern			
	Harvest	Escapement	Return	RTN/SP	Harvest	Escapement	Return	RTN/SP
1960	1,428	1,325.8	2,753		1,542	2,023.1	3,565	
1961	8,697	2,237.1	10,934		3,873	2,490.5	6,364	
1962	548	1,365.2	1,913	1.44	11,007	3,952.4	14,960	7.39
1963	13,914	2,828.4	16,742	7.48	5,145	3,757.9	8,903	3.57
1964	7,279	2,106.6	9,385	6.87	11,258	4,434.4	15,693	3.97
1965	5,154	2,211.6	7,366	2.60	5,710	3,188.8	8,899	2.37
1966	4,786	2,681.5	7,467	3.54	15,649	4,803.8	20,453	4.61
1967	2,425	1,673.2	4,098	1.85	642	1,669.4	2,311	0.72
1968	9,865	3,210.3	13,075	4.88	15,201	4,889.3	20,090	4.18
1969	3,594	2,142.3	5,736	3.43	1,198	2,070.2	3,268	1.96
1970	5,239	2,700.3	7,939	2.47	5,412	4,165.9	9,578	1.96
1971	3,011	2,958.2	5,969	2.79	6,250	4,822.9	11,073	5.35
1972	3,240	2,832.3	6,072	2.25	9,153	4,079.6	13,233	3.18
1973	1,875	2,363.8	4,239	1.43	4,555	3,395.4	7,951	1.65
1974	656	1,945.8	2,602	0.92	4,221	3,696.2	7,917	1.94
1975	615	1,558.4	2,173	0.92	3,330	4,777.8	8,108	2.39
1976	137	1,433.9	1,571	0.81	5,157	5,248.5	10,406	2.82
1977	2,506	4,162.7	6,669	4.28	11,242	6,175.0	17,417	3.65
1978	2,773	3,176.9	5,950	4.15	18,425	5,455.1	23,880	4.55
1979	3,813	5,082.6	8,896	2.14	6,992	4,820.1	11,812	1.91
1980	1,425	2,652.3	4,077	1.28	12,907	6,293.2	19,200	3.52
1981	5,334	4,054.0	9,388	1.85	13,468	6,014.5	19,483	4.04
1982	11,293	4,364.0	15,657	5.90	12,917	6,056.5	18,974	3.01
1983	6,044	4,780.4	10,824	2.67	31,421	8,806.5	40,228	6.69
1984	4,992	3,902.0	8,894	2.04	19,637	9,107.5	28,745	4.75
1985	21,098	9,009.8	30,108	6.30	30,612	12,344.5	42,957	4.88
1986	1,174	2,940.8	4,115	1.05	44,480	13,894.6	58,374	6.41

Appendix Table 2. Southern Southeastern pink salmon escapement by district and year in thousands of fish.

	District							SSE
	101	102	103	105	106	107	108	Total
1960	597.3	209.7	735.5	160.5	78.9	241.2	0.0	2,023.1
1961	671.4	174.3	653.1	268.0	317.3	193.0	213.4	2,490.5
1962	1,199.2	302.3	1,015.3	349.6	550.6	391.7	143.7	3,952.4
1963	876.1	250.0	1,104.4	395.3	464.3	462.8	205.0	3,757.9
1964	1,259.5	499.6	1,125.1	488.6	585.2	380.3	96.1	4,434.4
1965	636.5	256.6	1,138.0	402.3	447.8	269.3	38.3	3,188.8
1966	1,430.0	509.7	1,363.1	499.4	591.3	410.3	0.0	4,803.8
1967	461.7	88.6	397.6	342.8	219.9	136.3	22.5	1,669.4
1968	1,832.8	524.3	1,173.7	528.9	356.2	385.2	88.2	4,889.3
1969	717.6	309.8	414.2	182.2	183.8	159.2	103.4	2,070.2
1970	1,509.0	252.5	1,462.9	231.3	297.8	319.0	93.4	4,165.9
1971	1,347.6	636.0	1,573.2	336.6	411.6	475.1	42.8	4,822.9
1972	1,640.2	318.8	900.4	303.1	244.3	426.7	246.1	4,079.6
1973	903.5	518.1	818.8	293.9	368.3	395.4	97.4	3,395.4
1974	1,278.3	464.8	1,149.1	230.0	216.3	274.7	83.0	3,696.2
1975	1,444.0	668.8	1,438.2	309.3	403.5	483.6	30.4	4,777.8
1976	1,495.4	619.6	1,539.3	173.8	708.2	694.1	18.1	5,248.5
1977	2,235.0	673.9	1,607.6	278.7	357.4	956.6	65.8	6,175.0
1978	2,108.3	541.1	1,709.7	308.1	304.9	447.4	35.6	5,455.1
1979	1,056.9	649.7	1,654.4	475.8	389.9	475.5	117.9	4,820.1
1980	2,314.5	630.1	2,704.1	157.8	166.3	283.4	37.0	6,293.2
1981	1,904.0	594.0	2,553.3	376.5	264.4	288.9	33.4	6,014.5
1982	2,257.3	558.7	2,050.4	272.6	370.0	464.1	83.4	6,056.5
1983	3,100.4	1,140.6	3,302.8	550.7	284.0	384.5	43.5	8,806.5
1984	3,760.4	937.1	3,322.9	277.8	369.6	415.3	24.4	9,107.5
1985	3,861.1	1,163.9	4,693.2	649.1	903.2	978.6	95.4	12,344.5
1986	4,518.8	1,388.1	5,792.9	678.8	899.8	571.5	44.7	13,894.6

Appendix Table 3. Southeast Alaska 1986 pink salmon harvest (in numbers) by district and fishery.

Dist	Seine	Gillnet	Hand Troll	Power Troll	Trap	Total
101	10,442,446	909,969	13,211	9,362	458,900	11,833,888
102	5,288,554		4,922	4,179		5,297,655
103	7,050,013		11,291	2,503		7,063,807
104	18,868,678		17,184	35,380		18,921,242
105	513,109		2,708	2,784		518,601
106	373,852	307,906	6,001	1,187		688,946
107	146,945		2,763	376		150,084
108		4,901	0	1		4,902
109	471,911		17,903	8,789		498,603
110			268	155		423
111		16,481	33	14		16,528
112	334,871		2,425	43,214		380,510
113	112,268		19,902	66,400		198,570
114	14,551		18,549	5,490		38,590
115		38,098	3			38,101
116			622	1,703		2,325
152				412		412
154			106	458		564
156				42		42
157			24	259		283
180						
181				981		981
182						0
183				50		50
189				874		874
190						0
SSE	42,683,597	1,222,776	58,080	56,184	458,900	44,479,537
NSE	933,601	54,579	59,705	125,871	0	1,174,214
Region	43,617,198	1,277,355	117,915	184,613	458,900	45,655,981

Appendix Table 4. Northern Southeastern pink salmon escapement by district and year in thousands of fish.

	District							NSE
	109	110	111	112	113	114	115	Total
1960	103.8	228.9	260.2	173.3	430.8	108.9	19.9	1,325.8
1961	360.6	398.2	371.1	285.4	663.6	158.2	0.0	2,237.1
1962	388.8	307.1	215.1	145.4	252.4	56.1	0.3	1,365.2
1963	484.3	323.7	426.0	805.3	303.0	486.1	0.0	2,828.4
1964	681.5	466.2	289.6	424.6	104.7	140.0	0.0	2,106.6
1965	630.5	216.4	337.3	436.3	165.4	425.7	0.0	2,211.6
1966	659.7	431.2	455.4	620.3	420.9	94.0	0.0	2,681.5
1967	333.9	197.7	269.6	340.7	380.3	147.5	3.5	1,673.2
1968	694.0	967.7	458.6	580.0	298.2	164.6	47.2	3,210.3
1969	355.9	275.7	241.8	471.3	536.5	251.0	10.1	2,142.3
1970	469.1	529.5	443.5	684.0	348.5	171.5	54.2	2,700.3
1971	487.5	595.6	283.0	594.5	604.0	393.6	0.0	2,958.2
1972	430.0	727.2	606.2	558.2	316.7	194.0	0.0	2,832.3
1973	309.1	302.8	288.0	526.9	586.5	261.4	89.1	2,363.8
1974	292.0	290.9	444.6	358.9	427.1	132.3	0.0	1,945.8
1975	209.0	88.1	157.0	294.0	663.4	136.8	10.1	1,558.4
1976	230.9	192.5	103.4	267.9	502.8	136.4	0.0	1,433.9
1977	503.5	283.9	352.1	671.5	2,058.9	242.5	50.3	4,162.7
1978	463.7	428.0	205.5	1,005.5	867.4	206.7	0.1	3,176.9
1979	730.8	731.7	493.1	830.0	1,964.5	251.8	80.7	5,082.6
1980	428.7	415.3	283.3	639.2	608.7	243.6	33.5	2,652.3
1981	363.8	389.3	299.1	767.9	1,948.5	240.0	45.4	4,054.0
1982	764.1	614.9	731.2	844.8	1,155.9	203.5	49.6	4,364.0
1983	586.0	396.0	761.0	829.3	1,880.5	272.9	54.7	4,780.4
1984	695.5	443.5	466.5	483.9	1,577.2	205.4	30.0	3,902.0
1985	1,162.6	1,084.2	1,803.3	1,363.4	2,749.8	581.0	265.5	9,009.8
1986	739.8	287.8	215.1	780.6	737.4	179.3	0.7	2,940.8

Appendix Table 5. Water temperatures and salinities at two meters depth, and associated secchi disk readings, Tenakee Inlet, May 1985.

	May	Temperature	Salinity	Secchi
Trap Bay	7	8.90	27.70	5.5
	14	7.60	27.60	9.0
	21	7.40	29.90	5.0
	27	9.40	25.90	5.2
	June 4	10.80	18.80	5.9
Mean		8.82	25.98	6.12
Standard deviation		1.25	3.81	1.47
Cannery Point	7	7.10	31.00	5.0
	14	9.80	28.20	8.2
	21	6.80	28.90	5.5
	27	8.20	29.90	5.4
	June 4	10.10	25.90	5.4
Mean		8.40	28.78	5.90
Standard deviation		1.35	1.72	1.16
Tenakee	8	7.20	29.10	
	15	8.20	28.00	7.2
	21	9.00	26.10	5.5
	27	9.50	25.40	6.0
	June 3	12.20	18.80	6.0
Mean		9.22	25.48	6.18
Standard deviation		1.68	3.59	0.63
Kadashan	8	8.10	28.20	
	14	9.10	29.50	6.5
	21	8.20	26.80	6.0
	28	9.80	25.20	7.2
	June 4	11.00	15.80	7.1
Mean		9.24	25.10	6.70
Standard deviation		1.08	4.87	0.48
For All Primary (Nearshore) Stations, 1986:				
Mean		8.92	26.34	6.20
Standard Deviation		1.40	3.95	1.09
Sample Size		20	20	20

Appendix Table 5. Water temperatures and salinities at two meters depth and associated secchi disk readings, Tenakee Inlet, May 1985 (continued).

	May	Temperature	Salinity	Secchi
Hill Point	7	10.80	22.90	5.5
	14	7.30	28.40	7.2
	21	7.30	30.10	4.5
	27	9.10	28.70	5.5
	June 4	10.50	23.20	6.3
Mean		9.00	26.66	5.80
Standard deviation		1.50	3.00	0.90
Cannery Point	7	8.10	28.30	5.0
	14	9.50	27.80	8.5
	21	7.60	30.80	6.5
	27	9.10	28.20	5.0
	June 4	10.20	22.30	5.0
Mean		8.90	27.48	6.00
Standard deviation		0.94	2.80	1.38
Columbia Point	7	8.00	28.50	
	14	9.30	29.50	7.0
	21	7.10	28.10	6.0
	28	9.70	25.10	5.6
	June 3	11.20	17.90	7.6
Mean		9.06	25.82	6.55
Standard deviation		1.42	4.22	0.79
Sunshine Point	8	8.60	25.10	
	14	9.80	26.30	7.0
	21	8.80	26.50	7.0
	28	9.80	26.90	6.9
	June 3	11.50	16.90	7.4
Mean		9.70	24.34	7.08
Standard deviation		1.03	3.77	0.19
Tenakee-Kadashan	8	8.40	27.10	7.0
	15	7.90	30.60	7.0
	21	7.90	28.00	6.0
	28	10	24.50	6.60
	June 3	11.00	18.00	7.0
Mean		9.04	25.64	6.72
Standard deviation		1.25	4.29	0.39

Appendix Table 5. (Continued)

For All Secondary (Mid-Inlet)
Stations, 1986:

Mean	9.14	25.99	6.40
Standard Deviation	1.28	3.82	0.98
Sample Size	25	25	25

Appendix Table 6. Number of pink and chum salmon fry trapped in fyke Nets in Sunny Creek, Cholmondeley Sound, with stream temperature, 1976-1986.

SUNNY CREEK

DATE	1976 CHUM	PINK	TEMP	1977 CHUM	PINK	TEMP	1978 CHUM	PINK	TEMP
07-Apr							0	2	4
11-Apr	0	28							
13-Apr							1	21	4
15-Apr	0	116							
16-Apr	0	116					0	27	4
17-Apr	0	116							
19-Apr							7	178	4
21-Apr	0	163	1.1						
22-Apr							0	203	6
27-Apr	0	352							
28-Apr	0	528					6	197	6
29-Apr	0	356							
30-Apr	0	633							
05-May				33	242	3.5	40	268	5
07-May	0	753	3.3						
08-May	0	744	2.8	46	329	3	14	246	6
09-May									
11-May							25	117	8
14-May				50	190				
15-May	4	802	2.8						
17-May	11	1281	2.8						
18-May							5	80	7
20-May				173	691	3.5			
21-May							1	30	8
22-May							7	53	7
23-May				111	1262				
26-May									
28-May	3	314	3.9						
30-May				184	999	4.8			
31-May							3	15	8.5
01-Jun	4	331	3.3						
04-Jun	5	341		42	992	4.5			
06-Jun							1	0	10
07-Jun				35	1144	5.8			
11-Jun				4	151	4.3			
14-Jun				3	294	7			
17-Jun	19	23							
18-Jun				3	36				
20-Jun				2	24	5			

-Continued-

Appendix Table 6. (Continued)

SUNNY CREEK

DATE	1981 CHUM	PINK	TEMP	1982 CHUM	PINK	TEMP	1983 CHUM	PINK	TEMP
06-Mar	15	16							
26-Mar	169	240	5						
27-Mar	161	229							
10-Apr	113	48	5						
12-Apr	219	19							
14-Apr				2	20	2	17	41	6
16-Apr				0	28	2			
21-Apr							410	205	7.5
22-Apr	230	260	7	16	9	3			
23-Apr	167	314		15	13	2			
29-Apr				43	16	3.5	367	120	11
30-Apr				43	19	3	523	465	11
04-May							417	1051	
05-May	102	25	10				468	1436	7.5
06-May	98	20	11						
09-May				38	12	4			
10-May				94	304	4			
11-May							255	621	10
12-May							438	820	7
14-May				222	570	3			
15-May				172	397	4.5			
17-May	1	0	9						
18-May							606	148	7
19-May							468	236	7
25-May				105	336	4			
27-May							119	22	9
02-Jun				40	145	6			
03-Jun				52	324	5			
10-Jun				19	364	6			
19-Jun				0	3	7.5			

DATE	1984 CHUM	PINK	TEMP	1985 CHUM	PINK	TEMP	1986 CHUM	PINK	TEMP
17-Apr				35	100	1			
24-Apr				106	232	1			
29-Apr	75	312	6						
30-Apr							120	2188	4
04-May				239	772	1			
07-May							192	2306	3
09-May	198	681							
14-May							42	1329	4
16-May	463	219	7	287	1337	5			
20-May				129	495	5.5			
22-May							458	1459	5
23-May				224	894	5			
26-May				194	831	7.5			
29-May				81	94	7			
30-May							469	884	6
04-Jun				166	252	8			
06-Jun	27	20	8	184	572	8			
08-Jun				1	3				
10-Jun							533	68	10

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